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LIST OF MEMBERS

Entomological Society of British Columbia (May, 1943)

Allen, Miss M.—956 - 14th Ave. W., Vancouver, B.C.

Andison, Harry—Fruit Insects Lab., Vernon, B.C. Ecatomic ent.

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Buckell, E. Ronald—Field Crop Insect Lab., P.O. Bldg., Kamloops, B.C. Orthoptera of Canada; Odonata and bees of B.C. Exchange. Det. local Orthop. & Odonata.

Buckell, W. E.—Salmon Arm, B.C. Lepidoptera.

Carl, G. Clifford—Director, Provincial Museum, Victoria, B.C.

Comstock, John A.—Los Angeles County Museum, Exposition Park, Los Angeles, Calif. In charge Museum colls. Lepidoptera; exchange; det. west coast species.

Cowan, Ian McT.—Dept. Zoology, Univ. Brit. Col., Vancouver, B.C. Mammals; birds. Coll.

Crum, S. E.—Box 233, Puyallup, Wash.

Cudmore, R. H.—Canadian Industries Ltd., New Westminster, B.C. Insecticides.

Davidson, John—Office of the Herbarium and Botanical Gardens, Univ. Brit. Col., Vancouver, B.C. Flora of B.C.

Doucette, C. F.—U.S.D.A. Experiment Sta., Sumner, Wash.

Downes, W.—c/o Dept. Agric., Parliament Bldgs., Victoria, B.C. Heteroptera, Homoptera. Coll., exchange, det.

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Finlay, A. W.—Huntingdon, B.C. Provincial Apiarist.

Fisher, J. Dean—c/o G. Allen Mail, Kamloops, B.C.

Foster, Ray E.—1575 Kamloops St., Vancouver, B.C. General ent.

Foxlee, Harold H.—Robson, B.C. Lepidoptera, Asilidae; Ichneumonidae; Ephemerida. Small coll. Will coll. for sale.

Fulton, Harry G.—152 Mellard Ave., Chilliwack, B.C. Coccinellidae; coll.

Furniss, R. L.—445 U.S. Court House, Portland, Ore. Forest ent. Coll. forest Coleoptera, esp. scolytids, clerids, cerambycids, buprestids.

Getzendaner, G. W.—Box 218, Union Gap, Wash.

Glendenning, R.—Dom. Expt. Sta., Agassiz, B.C. Economic ent. Aphididae.

Goddard, V. E. L.—Haliburton Rd., Royal Oak, Victoria, B.C.

Graham, Kenneth—Forest Insect Investigations, 320 Central Bldg., Victoria, B.C. Forest ent.

Gregson, J. D.—Box 210, Kamloops, B.C. Ixodidae N. Am., esp. Canada. Coll., det. exchange.

Hanham, A. W.—Duncan, B.C. Not active at present.

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Hatch, Melville H.—Dept. Zoology, Univ. Washington, Seattle, Wash. Coleoptera, esp. of northwest. Coll.

*Haug, Gordon—Kelowna, B.C. Ants.

Heriot, A. D.—Fruit Insect Lab., Vernon, B.C. Adelginae; physiology of codling moth. Det. adelgids.

Holland, George P.—Livestock Insect Lab., Kamloops, B.C. Siphonaptera. Coll., exchange, det.

Hopping, Geo. E.—Box 803, Vernon, B.C. Coleoptera (Cerambycidae, Buprestidae, Scolytidae). Coll., exchange, det.

Hoy, Ben—Provincial Horticultural Branch, Kelowna, B.C. Orchard insects.

Jennings, Kenneth—755A Yates St., Victoria, B.C. Insects affecting flowers.

Jones, J. R. J. Llewellyn—"Arranmore", R.R. No. 1, Cobble Hill, B.C. Lepidoptera, esp. Nymphalid, of B.C. Coll., does not exchange.

Kincaid, Trevor—Dept. Zoology, Univ. Washington, Seattle, Wash.

Laing, Arthur—c/o Buckerfield's Ltd., Vancouver, B.C. Insecticides.

Leech, Hugh, B.—Box 308, Vernon, B.C. Nearctic water beetles (Dytiscidae, Gyrinidae, Hydrophilidae). Coll., exchange, buy, det.

Mail, G. Allen—171 Nicola St., W., Kamloops, B.C. Culicidae, coll., exchange.

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Marshall, James—Box 308, Vernon, B.C. Insecticides.

Mathers, W. G.—Box 308, Vernon, B.C. Fruit insects.

Mennie, Thomas P. O.—Curator, City Museum, Hastings St., Vancouver, B.C. General ent., coll. exchange.

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Morgan, Cecil V. G.—Box 308, Vernon, B.C. Forest insects.

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Rukmann, M. H.—Tranquille Sanitarium, Tranquille, B.C. Retired.

Ricker, W. E.—Dept. Zoology, Indiana Univ., Bloomington, Ind. Plecoptera, Coll., det.

Spencer, G. J.—Dept. Zoology, Univ. of Brit. Col., Vancouver, B.C. Coll. all orders except Odonata, Coleopt., Lepid. Esp. interested Thysanura, Corrodentia, Mallophaga, Anoplura, Neuroptera, Siphonaptera; Diptera fam. Tabanidae, Bombyliidae, Ichepodae, Trypetidae, Gasteruphilidae, Oestridae, Sarcophagidae; Pupipara. Exchange; det. Anoplura.

Stage, Harry H.—Bureau of Entomology and Plant Quarantine, Washington, D.C. Mosquito control.

Stainer, John—Okanagan Mission, B.C. Bumblebees.

Steele, G. L.—c/o Dept. Zoology, Univ. of Brit. Col., Vancouver, B.C.

Thompson, B.G.—Dept. Entomology, Oregon State College, Corvallis, Ore. Aegerilidae, esp. western spp.

Toumeu, W. E.—5612 Argyle St., Vancouver, B.C.

Twidle, Henry—Granite Bay, B.C. Lepidoptera.

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Waddell, David B.—624 Huron St., Toronto, Ont.

Ward, Ivor—Provincial Entomologist, Dept. Agric., Vernon, B.C.

* Wellington, W. G.—c/o Dept. Zoology, Univ. of Brit. Col., Vancouver, B.C.

Wilcox, Joe—P.O. Box 297, Alhambra, Calif. Diptera, Asilidae.

Willett, Victor—Okanagan Mission, B.C. Coleoptera.

Winson, J. W.—Huntingdon, B.C.

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* At present serving with the armed forces.

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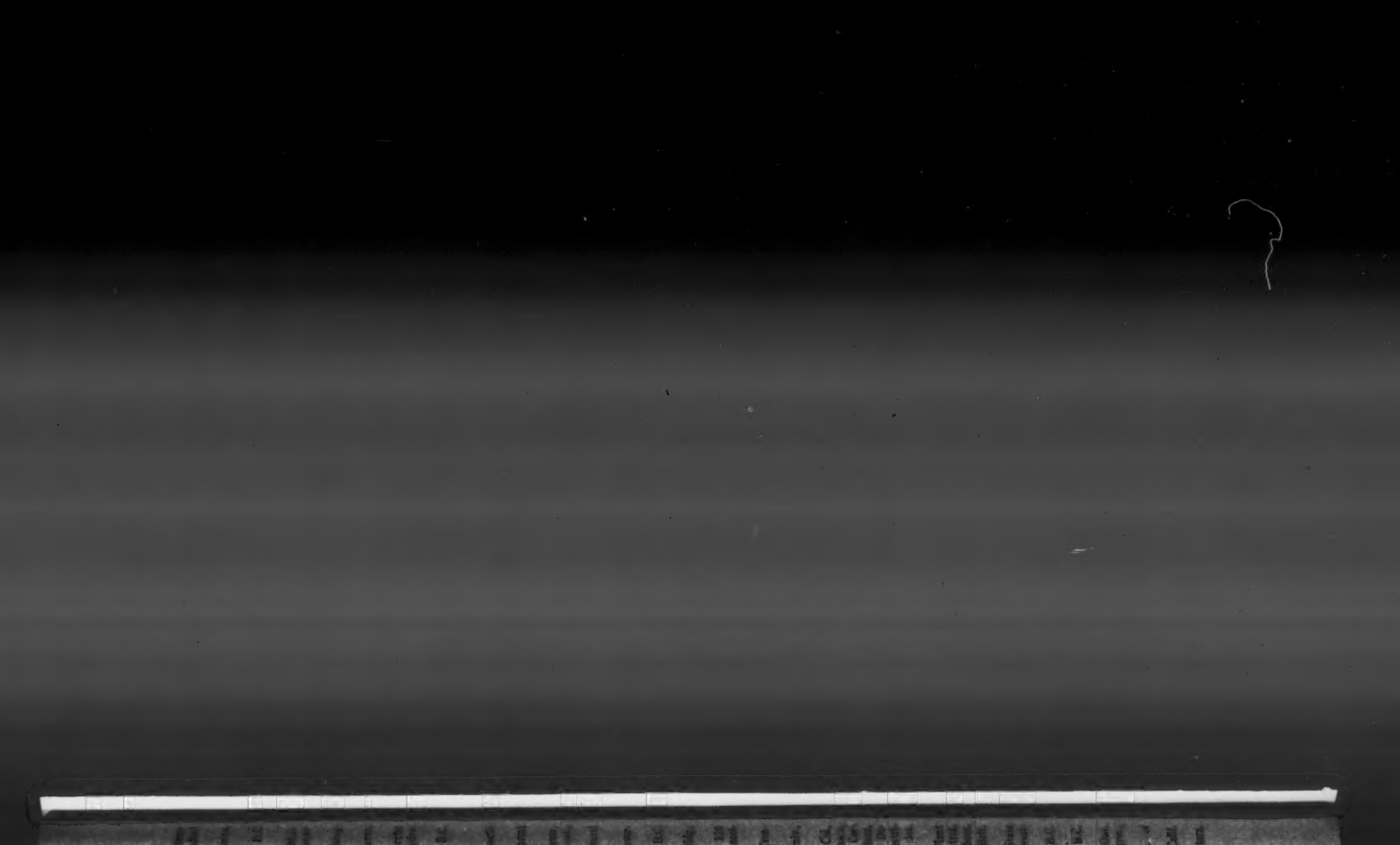

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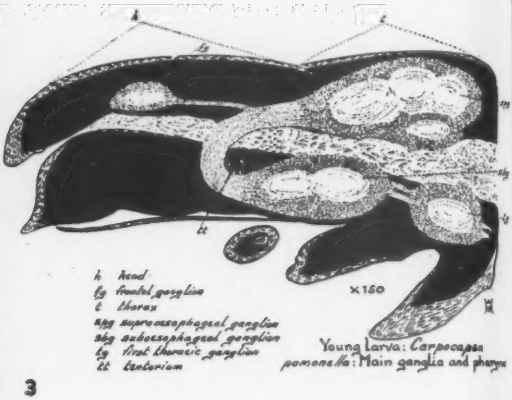
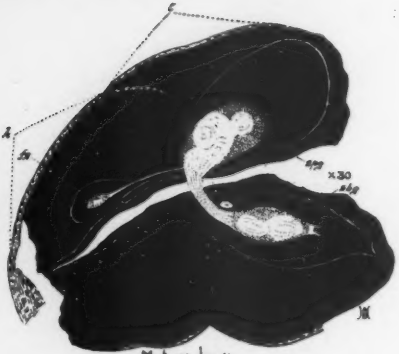
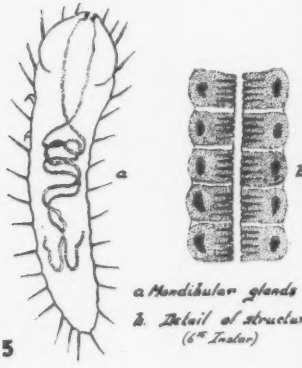


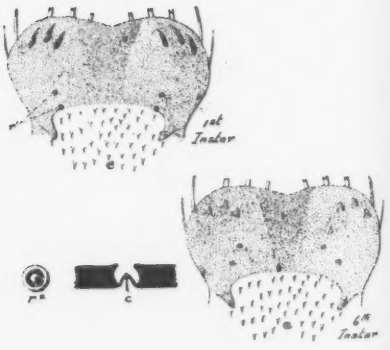
3 Young Larva: *Carpocapsa pomonella*: Main ganglia and pharynx



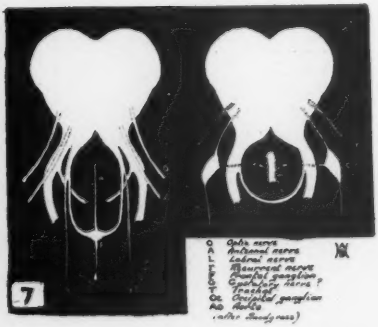
4 Mature larva
Carpocapsa pomonella: Main ganglia, white lines denoting proportional size of ganglia and pharynx to those of young larva



5 a Mandibular glands
b. Detail of structure (6th Instar)



6 Ventral view of labrum showing e epipharynx
r' receptors r² receptor enlarged
c sensillum coeloconicum (after Weber)



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LARVAE OF CARPOCAPSA POMONELLA—Heriot

HOW DOES LEAD ARSENATE PREVENT THE YOUNG CODLING MOTH LARVA FROM INJURING THE FRUIT?[1]

A. D. HERIOT

Dominion Entomological Laboratory, Vernon, B.C.

Introduction

Information on the behaviour of newly hatched codling moth larvae on foliage and fruit has been given in previous papers from the Dominion Entomological Laboratory at Vernon; Heriot and Waddell (1942), Waddell and Marshall (1942). The following account represents an extension of these investigations. The conclusions and inferences are based partly on investigations reported in the literature and partly on original work.

Laboratory experiments with lead arsenate against first instar codling moth larvae have not, as a rule, given the degree of control that is generally attained under orchard conditions, although even in the latter case results often leave much to be desired. Nevertheless, lead arsenate still holds a prominent position in the codling moth spray schedule and it continues to be used in the field as the standard of effectiveness for experimental larvicides.

Not many years ago, it was sufficient to explain any apparent ineffectiveness of this material as being due to careless spraying. That explanation no longer suffices, since examples of poor control despite thorough application, are now commonplace in the arid or semi-arid apple-growing districts of Western North America. The reason for this lack in control, apart from the possible segregation of a race of codling moth resistant to insecticides, may become apparent when a clearer idea is obtained of how and when the action of lead arsenate takes place.

Results of Experiments, with Comments

The results of experiments bearing directly on the question under discussion, cover the period extending from the time the larva prepares to leave the egg until it enters the fruit. Where figures are given in this brief summary, experiments have been replicated many times. Where figures are omitted, the evidence is merely suggestive.

A heavy residue of lead arsenate on the chorion of the egg failed to prevent the larva from biting its way out during eclosion. This is not surprising as the chorion is generally torn open by the mandibles rather than bitten through, and to correspond with a residue on the fruit, the lead arsenate would have to be on the surface attacked, namely, the inner surface of the chorion.

After the larva leaves the egg, it must first locate the fruit and then find a suitable site for entry. On sprayed trees this generally entails crawling over a residue on the apple for 30 minutes to several hours. That this should afford ample opportunity for particles of arsenical to come in contact with the mouthparts and preoral cavity is indicated by the following experiment: 67 per cent of the larvae that crawled over a residue of finely divided graphite on Bristol board, picked up and sometimes swallowed particles of graphite in the space of 5 minutes, notwithstanding the fact that the surface was foreign to the normal environment of the larvae and presumably unattractive.

All larvae that crawled for one hour over the surface, showed particles of graphite in the ventriculus. On the other hand, when lead arsenate was added to the graphite, only 12 per cent instead of 100 per cent of the larvae were found to have graphite in the ventriculus; furthermore, less graphite was ingested by each larva. It is difficult to account for this difference if lead arsenate re-

[1] Contribution No. 2254, Division of Entomology, Science Service Department of Agriculture, Ottawa, Ontario.

mained completely insoluble and hence inactive. It seems logical to believe that the arsenical became sufficiently soluble within the preoral cavity to be detected by the larva and that solubility was effected by the secretion of the mandibular glands ("saliva"). If lead arsenate in solution is repellent in the case of admixed graphite-lead arsenate, then it is conceivable that ingestion of graphite particles would be reduced and the lead arsenate, at least in particulate form, might be even more strongly rejected. As for solubilized arsenic, the amount inadvertently ingested would appear to be negligible, at least from the standpoint of direct lethal effect, since larvae may crawl over a lead arsenate residue for several hours without apparent injury.

It was found that larvae were much more reluctant to feed upon apple leaves that had been sprayed with lead arsenate than upon unsprayed leaves. Only 20 per cent of the larvae attacked sprayed leaves after being restricted to these for 15 hours, whereas under similar conditions, unsprayed leaves are readily fed upon. Ninety per cent of the larvae that actually fed on sprayed leaves lived for 15 hours or more although some consumed as much as 5 square millimeters of leaf. A similarly high percentage of larvae survived after successful entries through a residue of lead arsenate deposited over a puncture made in the skin of the apple with the point of a dissecting needle.

Experiments at this laboratory indicate that the repellence of lead arsenate residue may be so great that a high percentage of larvae may starve rather than bite through it, and further, when leaf tissue or apple pulp is consumed the repellence of lead arsenate is reduced. On the other hand, when sodium arsenite was substituted for lead arsenate on apples with the cuticle removed, few larvae fed and none entered. Perhaps the degree of acidity of the fruit and leaves is sufficient to maintain lead arsenate in an insoluble condition as it passes quickly into the mouth, while the more soluble sodium compound is not so affected.

Investigations show that larvae will consume particulate lead arsenate with food, and in the same way soluble arsenic may sometimes be ingested. In the case of larvae that fed upon apple pulp treated with sodium arsenite, there soon was a complete cessation of the peristaltic movements of the stomodaeum, although movement persisted for some time in the ventriculus and proctodaeum. When lead arsenate is ingested with food, peristaltic movement appears likewise to be affected though to a lesser degree. Figure 1 shows the normal distribution of food after 5 minutes of feeding on pulp dusted with graphite. Figure 2 shows the distribution of food with graphite plus lead arsenate after 2 hours. In the latter case, as in numbers of others under like treatment, clots of food were held up in the mouth, in the pharynx, and in the crop instead of normally passing on to the ventriculus.*

Voskresenskaya, whose work is discussed at some length by Hoskins (1940) records retention of food in the foregut, arising out of the use of sodium arsenite on three different insects, namely, the cutworm, the cabbage worm, and the cricket. She explains this as due to the depressing influence of arsenic on the nervous system governing intestinal movement. This produces a relaxation of the sphincter lying between the crop and midgut, presumably brought about by absorption of arsenic in the midgut. Figures 2, however, suggests a relaxation of the muscles of the pharynx governing swallowing, as well as a relaxation causing stoppage in the crop. This condition may be due to lead arsenate breaking down in the stomodaeal fluid. There appears to be no conclusive evidence that the walls of the stomodaeum are impermeable to substances in water solution. As a matter of fact, their derivation

* The crop does not appear to act as a receptacle for storage except when the insect has to be tided over a period of quiescence.

from the ectoderm and the demonstration that the ectoderm in wireworms is permeable to aqueous solutions of arsenic (Woodworth 1938) may be significant.

A symptom of what is regarded as stomach poisoning but which may be this condition of stoppage in the crop, is a clear watery exudation from the anus. A spot of the glistening residue of this excrement near the site of a larval injury is generally a sign that the larva responsible for it has died. Regardless however, of the precise manner in which death is brought about by the ingestion of lead arsenate, a most important point from the standpoint of the fruit-grower is that in the majority of cases death by ingestion apparently does not happen soon enough to prevent injury to the fruit.

Discussion

Acid lead arsenate is only slightly soluble in water and there is nothing to suggest that it affects the codling moth larva in the ordinary sense of a contact insecticide. Until the importance of the pH value of the digestive fluids was realized, it was difficult to understand how this very stable material could even act as a so-called stomach "poison". It is now generally assumed, somewhat too readily perhaps, that lead arsenate is ingested and breaks down to liberate soluble arsenic in the alkaline digestive fluids of the ventriculus, absorption then taking place and arsenic passing into the blood stream to pervade the tissues of the body with lethal effect.

This sequence of events which often requires a matter of hours or days, is known to occur in some leaf-eating lepidopterous larvae. These, when feeding on sprayed foliage, swallow the arsenical with their food. The amount of arsenic experimentally administered to such larvae has in some cases, been recovered from the excreta, blood, and tissues. (Voskresenskaya, as quoted by Hoskins 1940).

When restricted to a diet of lead arsenate-sprayed leaves, the young codling moth larva swallows the arsenical with its food. Incidentally, of course, the leaves are injured. But since in the orchard lead arsenate usually prevents the larva from injuring the fruit even by so much as a sting, it is reasonable to infer that the action of lead arsenate when on the fruit must be different in some respects from its action when on the leaves.

Possibly the situation is further complicated. Mature larvae, chiefly because of their size, have been generally used for direct experimentation with stomach insecticides. But as shown in figures 3 and 4 the young larva is not a small edition of later instars. Relatively it possesses a far greater proportion of nerve tissue. Indeed it might be aptly described as a "bundle of nerves" in contrast to the condition obtained in the mature larva. Is it too much to speculate that with such a profound change in anatomy there might go a change in physiology; that the first instar larva might be more susceptible either to the lethal effect or to the repellent effect of a compound such as lead arsenate?

If lead arsenate must pass into the ventriculus before it can be broken down, the time required for this and the subsequent chain of events leading to death, would apparently allow the larva to cause noticeable injury to the fruit. Under favourable conditions, an entry can be effected in 15 to 30 minutes, yet experiments indicate that when unaccompanied by food, ingested solids such as graphite, carmine, and lampblack require from 30 to 60 minutes to reach the ventriculus. Therefore, if lead arsenate is to prevent blemishes, it must exert action prior to arrival in the ventriculus.

It is common knowledge that preliminary to feeding, the larva removes and rejects the comparatively tough and dry cuticle of the fruit; actual feeding only taking place when the moist tissues of the cortex are exposed. In the task of penetrating the cuticle, the mouthparts of the larva are engaged in "spitting out" each fragment of cuticle laboriously

chewed off by the mandibles. This procedure is therefore the very reverse of that accompanying ingestion. The removal of the cuticle is a slow process and the amount of effort expended in chewing off each fragment can be measured by the fact that this operation requires from 30 to 40 seconds for its accomplishment and has to be repeated 20 to 30 times to expose the pulp. During this time, an arsenical deposit on the cuticle would seem to have an excellent opportunity of encountering the epipharynx which is studded with spine-like projections deflected to the rear. With this equipment the labrum as shown in Figure 4, becomes an ideal instrument for removing and retaining a residue in the preoral cavity as each fragment is rejected. Under such circumstances, the deposit would be subjected to unobstructed action of a copious secretion issuing from the highly-developed glands which open at the base of the mandibles (Figure 5) and, as suggested from its alkalinity, this secretion should be capable of breaking down lead arsenate. Granting the presence of suitable chemoreceptors within the preoral cavity as delineated in Figure 6, the larva might come under the influence of soluble arsenic almost immediately an attempt was made to "sting" the fruit. Moreover, since it has been demonstrated by other workers that arsenicals may be distinctly repellent to a variety of insects, it seems reasonable to conclude that repellent action may indeed take place in the manner described. According to Ripley and Petty (1932), the greater its repellence the less the likelihood of the toxicant being ingested.

Hoskins (1940) reviews recent contributions of physiology to insect control. Practically all the experiments discussed are concerned with adult insects or well-developed larvae, and Hoskins points out that susceptibility to toxicants may vary according to age. He refers to the saliva as the first body fluid with which an ingested substance comes in contact, but goes on to state that "no data showing an effect of insect saliva upon the toxicity of an insecticide seem to have been recorded."

The only work cited by Hoskins in his wide survey that appears to have a direct bearing on this point is that of Marshall (1939). From colorimetric and potentiometric determinations of the pH values of the digestive fluids of the codling moth larva, Marshall gives the following results: neutral or slightly acid in the proctodaeum; approximately pH 8.5 in the ventriculus; and slightly more alkaline in the crop. A statement that regurgitated fluid had a pH value of 9 and over appears to be significant when consideration is given to the fact, that so far as is known, the stomodaeal fluid arises only by intermittent regurgitation from the ventriculus, and from the secretions of the mandibular glands. (The labial or true salivary glands in the codling moth larva are given over to the production of silk). If, then, the stomodeal fluid should be more alkaline than that in any other portion of the alimentary canal it is quite possible this condition is brought about by a strongly basic secretion functioning as saliva but emanating from the mandibular glands.

According to Woodworth (1938), in the case of the wireworm, repellency of an arsenical may be such that none is ingested even while the insect burrows into an arsenically-treated bait. The wireworm has no salivary or mandibular glands and Woodworth's statement that arsenicals are repellent in accordance with their solubility is of interest. Woodworth moreover, surmises that sensory control of the mechanism of the mouthparts may account for the rejection of arsenicals by the wireworm. The nature of the sensoria responsible for this is not stated. Dethier (1937) claims that caterpillars in general have a strong sense of taste which is said to reside in the preoral cavity. He identifies no specific gustatory organs.

There is the authority of Weber (1933) for the supposition that the sen-

silla coeloconica or pit-peg sensoria in the preoral cavity could serve as gustatory organs. How these organs are innervated does not seem to be clear. As far as can be determined from the literature, it would appear that in lepidopterous larvae, the seat of olfactory responses lies in the tritocerebrum and that of gustatory responses in the frontal ganglion (Figure 7). Sectioning of grown larvae by the writer did not reveal a connection between the frontal nerve and the epipharyngeal organs. The question arises as to whether sensoria may be innervated in the first instar larvae yet not in later instars. It is hard to conceive of the senses of taste and smell being unconnected with the stomodaeal nervous system.

It was demonstrated by McIndoo (1929) that certain responses to external stimuli are positive in the young codling moth larvae and negative in older larvae. This perhaps, is another way of saying that sense organs that are functional in the first instar may be non-functional at a later stage, a possibility indicated in Figure 6, where one pair of chemoreceptors of the final instar are vestigial and the other pair are situated some distance from the periphery of the epipharynx. Also to be borne in mind in this connection, is the super-abundance of nervous tissue in the first instar larva.

So far as has been determined, it is only when the larva is effecting an entry into the fruit that the fragments of sprayed cuticle are held in the preoral cavity for an appreciable length of time. When the larva rejects these fragments some of the residue may be retained in the preoral cavity and the "saliva" may thus have an opportunity to bring into solution a sufficient amount of arsenic to stimulate the sensoria of the epipharynx. As noted earlier, it is believed that these sensoria initiate an avoidance response.

Although repellent action may appear to explain how lead arsenate prevents the larva from injuring the fruit, it by no means follows that lead arsenate is never ingested without food or that when it is ingested with food, it does not injure the larva. If the "saliva" is capable of breaking down lead arsenate on the threshold of the mouth, it should be equally capable of acting as a solvent when lead arsenate is conducted into the foregut.

With regard to ingestion without feeding, Marshall (1937) draws attention to the aggregations of particles of lead arsenate picked up by the larva in wandering over a residue and suggests a possible relationship between particles adhering to the mouthparts, and ingestion. He demonstrates that these aggregates assume greater proportions on oily than on non-oily deposits. Experiments with inert dusts indicate that some of these accumulations adhering to the mouthparts may be forced into the buccal cavity when the larva attempts an entry. It is not known whether repellent particles are ingested in the same way or whether the larva is deterred from even attempting an entry under such circumstances. But apart from repellent or toxic action, Marshall, Strew and Groves (1939) have shown that a residue of zinc oxide, presumed inert, may exert a definite influence on control evidently by physical or mechanical means.

A concluding word regarding the apparent ineffectiveness of lead arsenate despite thorough application: In laboratory experiments with larvicides it has been customary to use 10 or more larvae per apple. Smith (1926) used as many as 25 larvae per apple. Recent research has suggested that the use of such numbers of larvae may lead to erroneous conclusions. One or more larvae may partially remove the cuticle with its residue before becoming impotent, and other larvae may then exploit these preformed sites of attack in safety, to effect entries. Repeated experiments have shown that approximately half the larvae individually applied to apples are able to find a single minute puncture made with the point of a dissecting needle, even when the larvae

is deposited on the opposite side of the fruit to that on which the puncture is situated. Accordingly, it appears to be likely that in the orchard, larvae frequently and with success avail themselves of the attempted entries of predecessors. This may be a reason why inverted spray mixtures with their heavy deposits are better than non-inverted mixtures; why no residue other than one having a high contact value can be entirely effective; and why difficulty of control seems to increase more than proportionately as larval populations become greater.

Summary

Several ways are discussed in which a residue of lead arsenate may prevent young codling moth larvae from injuring fruit. Certain types of residue involving oils have been demonstrated to exert an influence on control by their physical or mechanical characteristics alone, but lead arsenate-casein-lime residue may owe its effectiveness chiefly to its repellent qualities.

Repellence is indicated by the reluctance of the larva to attack sprayed leaves and fruit; it appears to be at a maximum when the larva is removing the cuticle of the fruit prior to feeding. This task involves the "spitting out" and rejection of sprayed particles, a procedure which in part because of the structure of the labrum may result in some of the residue being retained in the preoral cavity. The strongly alkaline fluids present in the preoral cavity are believed to react quickly with acid lead arsenate and cause liberation of soluble arsenic. When soluble arsenic comes in contact with sensoria situated on the epipharynx, an avoidance response may be at once initiated.

Direct toxic action by ingestion seems to be the exception rather than the rule. Experiment suggests that it is doubtful if the various processes incident to systemic poisoning can take place with sufficient rapidity to prevent serious blemishes to the fruit.

The ordinary lead arsenate-casein-lime residue appears to become progressively less effective as a repellent as the larval population in an orchard becomes greater. This effect seems to result from the ability of the larvae to discover and to exploit previous attempted entries.

Acknowledgments—The writer is much indebted to Dr. J. Marshall for his help with regard to both the subject matter and arrangement of this paper. His published results have been freely used. Both Professor G. J. Spencer and Mr. J. J. de Gryse have been helpful in comments on the anatomical and physiological data involved and it was Mr. W. A. Ross who suggested the publication of these studies.

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A NOTE ON MITES (ACARINA) AND ASPERGILLUS (FUNGOUS) IN BALED MOULDY HAY

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In January of this year I received from a point in the lower Fraser Valley, an ounce vial of hay debris which was swarming with mites of several species; on the bottom of the vial were large numbers of very small, yellow bodies, globular in shape and of varying sizes. The message accompanying the hay stated that the sample came from baled hay which had been sold rather widely in the immediate vicinity and the farmers using it were greatly troubled over the effects of it on their cattle. Shortly after eating the hay the animals became afflicted with violent fits of coughing which became so serious that after three days this fodder was changed for another supply but it was three or four days longer before the coughing subsided. There seemed no intestinal disturbance or diarrhoea but the coughing was so violent tha the discharge of faeces from the cattle plastered the walls of the barns directly behind the cattle stalls. Farmers and two veterinary surgeons called in for consultation declared they had never seen anything like these attacks.

I promptly sent the sample of hay and the mites to the Dominion Entomologist with a plea for identifications and suggestions and he turned them over to Dr. H. H. J. Nesbitt of the Division of Entomology. Dr. Nesbitt returned me the following list of nine species of mites from that small sample of hay:

Acarus siro L. *(Tyroglyphus farinae)*

Atricholaelaps sp. (near *A. glasgowi* Ewing)

Cheyletus eruditus Latr.

Cheletomorpha venustissima (C. L. Koch)

Ctenoglyphus (Glyciphagus) plumiger (Koch)

Glyciphagus cadaverum Schr.

Sieulus sp. (near *S. plumiger* Oudms.)

Tyrophagus dimidiatus dimidiatus (Herm)

Scirus sp.

Some of these mites are vegetable feeders and some are parasitic upon the others. *Acarus siro* L. is the almost universal grain and flour mite; genus *Cheyletus* according to Banks, "contains many species; a number have been found on the skins of birds where they doubtless feed on the parasitic analgesid mites. They are very small (about 0.5 mm in length), live freely, and prey upon other mites and small insects. They seize the prey with their big palpi, insert the mandibles and suck it dry. Some have thought that there must be poison glands in the palpi, since the prey ceases movement very soon after capture." "The genus *Glyciphagus* does not appear to be as common in this country as in Europe; possibly owing to their minute size they have not been collected. One species occurs on seeds. The original species of the genus and some others have been found in sugar. The mites sometimes spread to the hands of those handling such materials and produce a skin disease known as "grocers itch." (I reported the occurrence of this mite causing "grocers itch" in a store in Nanaimo before this Society last year. See Proc. Ent. Soc. Brit. Col. **39**: 23. October, 1942). The other species of this list were apparently feeding upon the moulds in the hay or upon the fermenting hay itself.

Nesbitt remarked that he doubted whether any of the mites could have caused the effects which were reported from the cattle. And he continues: "You will notice, however, that we found the little sulphur-coloured fruiting bodies of an *Aspergillus* sp. Strasburger et al. in

their text book of Botany, 1912, say that some species of *Aspergillus* are pathogenic to man and other mammals and that *Aspergillus fumigatus* which lives in fermenting heaps of hay at a temperature of 40°C. causes mycosis of the external ear, throat and lungs. The suggestion is very strong that *Aspergillus* was the cause of the bovine trouble. That the hay has been mouldy at some time is evident from the fact that there was such a large population of Acarid mites and by the additional fact that spores of another mould *Mucor* sp. were found."

Now the fungus genus *Aspergillus* contains a large number of species which are widespread, occurring in soil and on straw, grain and vegetable matter. The species in general grow best at rather high temperatures, 35°C. to 40°C. (Henrici) (4). This condition would obviously occur in fermenting, mouldy hay as was the sample submitted. Dodge (2) lists 33 species of the genus which have been reported in various parts of the world as being pathogenic to human beings, laboratory animals and to birds. Several species are reported as occurring in the human ear, others as growing in human nails and one species described in France, in the lungs of an ass. Of these 33 species, the one at first sight appearing likely to fit our case is *Aspergillus fumigatus* Fresenius (with 5 synonyms) reported from various countries in Europe and from New York State. This is the commonest species isolated from cases clinically resembling tuberculosis of the lungs in which *Mycobacterium tuberculosis* has not been found. It apparently causes severe epizootics in birds and is less fatal in man, not reaching epidemic proportions. It is pathogenic for laboratory animals (Dodge) (2).

In these pathogenic records, however, fungus in one form or another was recovered from the tissues or sputum of affected animals, indicating an actual growth in the bodies concerned. In the instance under discussion here, the effect may have been induced in either one of two ways: (1) the simple ingestion of vast numbers of perithecia affecting the nervous system probably the vagus nerve, inducing violent contractions of the diaphram with consequent coughing; or (2) which is more likely, the mouldy hay was heavily infected with actual spores in addition to the small, yellow, globular perithecia and these spores, on being inhaled during feeding, induced irritation of the lungs and respiratory passages and produced the coughing.

Under the circumstances it is quite possible that a non-pathogenic species of *Aspergillus* was concerned, since the violent symptoms in the cattle cleared away within a few days after the mouldy hay was removed. It would seem, however, that the species is not common, otherwise the symptoms of distress in the cattle would have been frequently reported in the past, since the feeding of mouldy hay in this Province is by no means unusual.

Acknowledgments—I am greatly indebted to Dr. H. H. J. Nesbitt of the Division of Entomology, Ottawa, for identifying the mites and determining the fruiting bodies of **Aspergillus** and to Dr. F. Dickson and Mr. J. A. Rattenbury of this University, for the loan of literature.

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PHENOTHIAZINE AS A CODLING MOTH INSECTICIDE

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Phenothiazine (thiodiphenylamine), an organic insecticide, was first brought into prominence as a control for codling moth by E. J. Newcomer of the U.S. Bureau of Entomology, in 1936. (Phenothiazine, a promising new insecticide for codling moth control. Wash. State Hort. Assoc., Proc. 32nd. Ann. Meeting, p. 119-120. 1937). In 1937 the British Columbia Department of Agriculture in cooperation with the Dominion Entomological Branch conducted spraying trials with phenothiazine in the Hart orchard at East Kelowna and the Ramsay orchard at Okanagan Mission. [1]

According to the manufacturers, the material used in these tests contained a wetting agent, so nothing was added at the spray tank. Control, as Table 1 indicates, evidently was not as satisfactory as with arsenate of lead.

Table 1. Codling Moth Infestation at Harvest, 1937

Material per 100 gal.	Per Cent of Fruits Stung	Wormy
Ramsay Orchard		
Phenothiazine 2 lb.	13.4	21.
Arsenate of lead 3.2 lb. "Fluxit"* 0.25 lb.	15.6	5.1
Hart Orchard		
Phenothiazine 3 lb.	2.5	7.5
Arsenate of lead 3.2 lb. "Fluxit"* 0.25 lb.	1.5	2.5

*Proprietary spreader containing casein and hydrated lime.

In 1938 spraying tests were continued in the Hart orchard and phenothiazine was used in the same concentration as arsenate of lead. Both plots received arsenate of lead for the first three cover sprays. One of the plots received phenothiazine for the last two cover sprays while the other received the lead arsenate. The infestation at harvest is shown in Table 2.

1. The late A. A. Dennys of the Dominion Entomological Branch assisted in applying all sprays and checking apples in 1937 and 1938.

Table 2.—Codling Moth Infestation at Harvest, 1938

Material per 100 gal.	Per Cent of Fruits Stung	Wormy
Phenothiazine 3.75 lb.	3.0	2.2
Arsenate of lead 3.75 lb. "Fluxit" 0.25 lb.	6.3	2.4

Used at the same concentration as lead arsenate, phenothiazine gave equal control of worms, and a considerable reduction in the number of stings. Results in 1937 and 1938 applied equally to McIntosh, Stayman, Winesap, and Delicious. It was concluded that phenothiazine was as effective as lead arsenate for codling moth control when applied in comparable amount and uniformity. Because of high cost of material and pressure of other work, phenothiazine was omitted from our spraying experiments during 1939 and 1940. Field trials in 1941 and 1942 were conducted in the Keloka orchard at East Kelowna, in a mature McIntosh Red orchard [2].

Even at reduced concentration micronized phenothiazine with stove oil and soap gave codling moth control equal to the standard spray schedule of arsenate of lead and cryolite in 1941 and better in 1942.

Owing to heavy flocculation of phenothiazine in the spray tank some trouble was experienced in applying the mixture in the 1941 trials. In the last application 0.5 oz. casein and 4 oz. hydrated lime were added per hundred gallons. No further trouble was experienced and a heavy uniform deposit on the fruit and foliage resulted. The better cover obtained by the addition of casein-lime throughout 1942 undoubtedly was responsible for the improvement in control.

2. These trials were conducted in cooperation with the Dominion Division of Entomology, Vernon. Assistance was given by Dr. J. Marshall with spray formulae and by members of the Branch in applying the spray and checking apples.

Table 3.—Codling Moth Infestation at Harvest, 1941 and 1942

Material per 100 gal.		Per Cent of Fruits Stung	Wormy
1941			
4 Sprays arsenate of lead	3.3 lb.	9.8	10.9
"Fluxit"	0.2 lb.		
2 Sprays "Alorco" synthetic cryolite	3.75 lb.		
"Fluxit"	0.2 lb.		
3 Sprays arsenate of lead as above		5.6	9.8
3 Sprays micronized phenothiazine	1.8 lb.		
Monoethanolamine oleate	0.5 lb.		
Stove oil	0.25 gal.		
1942			
Arsenate of lead and cryolite as in 1941		1.8	3.5
Phenothiazine as in 1941 throughout the season except arsenate of lead in calyx spray		.9	1.4

No check was made for differences in size or color of fruit between the phenothiazine and standard schedule plots, but general observation throughout the season and at the time of examining the fruit at harvest revealed no marked differences. Superiority in this regard lay, if anything, with the phenothiazine. An undesirable feature of phenothiazine is that it causes irritation of the skin similar to sunburn. The lips are particularly affected. In 1941, girl thinners working in Keloka orchards the day following spraying had to be removed because of irritation to arms and face. Men thinners were not affected.

PREVENTION OF FRUIT DEVELOPMENT AND ITS EFFECT ON THE SURVIVAL OF THE CODLING MOTH

H. ANDISON [1] and H. H. EVANS [2]

In recent years considerable attention has been given to the possibility of spraying apple trees to destroy the blossoms without causing other injury. This procedure has been undertaken for the following purposes: (1) to eliminate a portion of the crop and so overcome the alternate bearing habit, (2) to thin the crop and so increase the size of the fruit left on the tree, and (3) to control certain orchard insects, particularly the codling moth. The practice of blossom removal by spray applications has been referred to as "deblossoming", a term which will be used here because it is concise and expressive.

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Review of the Literature

As yet, few definite recommendations have been made on deblossoming sprays. Holbeche (1941) found that 2 per cent "cresol" or 3 per cent tar-oil gave the most satisfactory results in removing an unprofitable crop. Gardner et al. (1939) in endeavoring to thin the apple crop by spraying at bloom period, used at 0.25 per cent to 0.5 per cent concentration, a commercial petroleum oil spray containing 4 per cent 2, 4-dinitro-6-cyclohexylphenol. The treatments were effective and appeared to cause no permanent injury to Duchess, Wealthy and Ontario apple trees. Results of five seasons' experiments by Shepard (1939) showed that 2 per cent cresylic acid and 3 per cent tar-oil were effective in destroying the blossoms of Beach, Champion, Willow Twig, York and Jonathan varieties and

there was no indication of persisting injury. Read (1941) found that 1 per cent cresylic acid gave the best results. Unsatisfactory results were obtained by Auchter and Roberts (1933) using lime sulphur, copper sulphate, sodium nitrate, sodium polysulphide and zinc sulphate. Magness et al. (1939) experimenting with 2,4-dinitro-6-cyclohexylphenol and tar oil showed that one application completely killed almost all the blossoms on Winesap, Delicious and Grimes. One year's observation by Harley and Moore (1940) indicated that 2 per cent tar oil applied at the rate of 60 to 70 gallons per tree during late cluster-bud stage resulted in 96 per cent blossom removal on Delicious, Winesap, King David and Stayman.

Since it has been commonly felt that early removal of the crop would at least reduce the population of the codling moth to a very low level, it seems logical to assume that deblossoming sprays might be useful in controlling this insect. The literature on the subject suggests that the value of bloom-killing sprays in codling moth control would depend upon (1) the percentage of the larvae that live two winters before emerging as moths and (2) the importance of fruit to survival of the codling moth.

Regarding the possibility that this insect may remain in the larval state for two winters, Yothers and Carlson (1941) during the period July 6 to November 10, 1939, found thousands of larvae still alive in their cocoons in the soil at or near the base of apple trees bearing practically no crop. As some of these specimens were observed before many of the "first brood" larvae had left the fruit on adjacent trees, it was concluded that they must be non-transforming larvae remaining from the previous (1938) season. The possibility that these larvae may have matured on other tissue than fruit is not mentioned. Brodie (1906) reported that a few codling moth larvae which cocooned July 1905, remained unchanged October 1906 and stated that "moths would not emerge from these until the spring of 1907." Whether or not he succeeded in rearing the moths during 1907 is not known. Survival of a very small number of "two-year" larvae was noticed by Hammar (1912), Siegler and Brown (1928), and Longley (1921), but none of these workers succeeded in rearing moths from them. Wakeland and Rice (1932) report that "a few individuals studied required more than a year to complete their life cycle," but no data are included to support this statement. Thus as far as can be learned from the literature, there is no conclusive proof that codling moth larvae may survive two winters and subsequently perpetuate the species.

The second important point in considering the usefulness of crop removal measures in codling moth control is to know whether or not this insect can complete its life cycle in the absence of fruit. In the laboratory, Heriot and Waddell (1942) and Speyer (1932), were successful in rearing moths from larvae fed on leaves alone, but the moths derived were unusually small, short-lived specimens, and produced no eggs. Hall (1928) also succeeded in rearing larvae to maturity on apple leaves but they failed to pupate. Under field conditions, Marshall (1940) observed that large numbers of larvae developed to maturity on a caged Benoni apple tree from which the crop was removed. Newly-hatched larvae, not finding any fruit, fed on fruit buds and spurs, sap shoots, leaf bases, new breaks in twigs and small branches (4-year old wood), enlargements caused by the feeding of woolly aphids, and leaves alone. Hundreds of these larvae matured and entered bands on the tree trunk in the fall but Marshall does not say whether or not they pupated the following spring. Spur-burrowing in Anjou and Bosc pear fruit spurs by codling moth larvae is reported by Gentner (1940) as a common occurrence in Rogue River Valley, Oregon. The young larvae burrow into fruit spurs with fruit attached,

during both the first and second brood periods. Larvae were found to complete their development and transform to moths but their capability for producing fertile eggs is not mentioned. Although it is probable that the codling moth can perpetuate the species in the absence of fruit, this point apparently has not yet been established with certainty.

To determine the feasibility of removing an apple crop by chemicals and to determine further the value of such a procedure in control of the codling moth, co-operative projects were undertaken by the British Columbia Department of Agriculture and the Vernon Laboratory of the Division of Entomology, Dominion Department of Agriculture.

Experiment on the Killing of Apple Blossoms

On April 29, 1942, a block of 121 Jonathan and Grimes' Golden trees at Okanagan Centre was sprayed in the pink stage when many blossom clusters were not separated. A portable two-gun sprayer regulated at 500 pounds pressure was used. Disc apertures were 7/64 inch. The block of trees was divided into six plots which were sprayed with the following materials:

Table 1. Plots and Spray Materials Used in Apple Deblossoming Experiment.

Plot	Materials per 100 Imperial gallons		Amount of spray per box capacity of tree
1	"Dowspray Dormant" (1)	1.0 gal.	0.25 gal.
	Lignin pitch (2)	4.0 oz.	
2	"Dowspray Dormant"	1.5 gal.	0.25 gal.
	Lignin pitch	4.0 oz.	
3	"Dinitro Dry" (3)	1.2 lb.	0.75 gal.
	Oil - 117 S.S.U., 64% U.R., (Mid - continent crude)	1.0 gal.	
	Lignin pitch	4.0 oz.	
4	"Dinitro Dry"	1.8 lb.	0.75 gal.
	Oil - 117 S.S.U., 64% U.R., (Mid-continent crude)	1.5 gal.	
	Lignin pitch	4.0 oz.	
5	"Dinitro Dry"	1.8 lb.	0.75 gal.
	Oil - 245 S.S.U., 62% U.R., (Calif. crude)	1.5 gal.	
	Lignin pitch	4.0 oz.	
6	"Dinitro Dry"	1.8 lb.	0.75 gal.
	Lignin pitch	4.0 oz.	

(1) "Dowspray Dormant" Manufacturer's analysis: dormant oil 100-110 S.S.U. (Mid-continent crude) and 2,4-dinitro-6-cyclohexylphenol 4 per cent by weight.

(2) "Copacite", a by-product of the calcium bisulphite paper making process.

(3) "Dinitro Dry" Manufacturer's analysis: 4,6-dinitro-ortho-cresol 50 per cent, inert material [bentonite?] 50 per cent.

Examination of these plots on May 14, showed that the trees in plots 1 and 2, which were lightly sprayed with 2,4-dinitro-6-cyclohexylphenol - oil mixture, had less than 20 per cent of the blossoms killed and only a small amount of foliages injury. Trees in plots 3, 4, 5 and 6, which received a thorough spray application of 4, 6-dinitro-ortho-cresol either alone in water or with oil, had 80 to 95 percent of the blossoms killed. At the same times, however, a considerable number of fruit spurs were killed, so for blossom-removal the treatments appear to be too radical. Since the lightly sprayed trees in plots 1 and 2 were evenly thinned without serious spur damage, further work with dinitrophenol derivatives is planned by the British Columbia Department of Agriculture in order to determine if chemical thinning is practicable.

Experiment on the Effects of Blossom Removal on Codling Moth Infestation the Following Year

To determine the value of deblossoming sprays in codling moth control an experiment was commenced at Oyama, B.C., during 1941. About one-half acre of 20 to 30-year old McIntosh, Wealthy, and Delicious apple trees, some 300 yards from the nearest orchard, was sprayed in the pink stage with a 2 per cet emulsion of high-boling, neutral tar oil. Emulsification was accomplished by lignin pitch. The centre McIntosh blossoms were just opening, but the Delicious and Wealthy blossom clusters were not all separated, so in view of evidence in

the literature, the spray was probably applied somewhat too early for best results, with these varieties. Application was thorough, approximately one gallon of spray being applied per box of fruit that the trees were capable of bearing. About 90 per cent of the blossoms were killed by the spray. During June, fruits which set were removed by hand before any first generation larvae had matured. Dropped fruits were also collected and destroyed.

As far as could be determined, no worms developed in apples in this block of trees in 1941. Nevertheless, after half an hour's examination by three men on April 17, 1942, 7 larvae and one pupa were found beneath bark scales near the base of the trees. This material was caged in the laboratory and 7 moths emerged from it during the following May and June. While it is probable that these moths developed from two-year-old larvae, there is yet a possibility the larvae developed during the previous season (1941) on the trees devoid of fruit.

The trees were not sprayed in 1942 and when examined at harvest, the light crop was found to be heavily infested. Fruits on McIntosh, Wealthy and Delicious trees were 65, 85 and 90 per cent wormy respectively. The infestation may not have resulted entirely from hibernating larvae in the treated orchard for it is possible that moths immigrated from surrounding infested orchards. The main point is that although crop removal was more thorough than would have been accomplished by most growers, it did not prevent a ruinous attack by codling moth the following year. Accordingly, deblossoming or other means of crop removal apparently cannot be considered a procedure worthy of recommendation for control of this insect in a two-generation area such as the Okanagan Valley. Perhaps, however, it may be found feasible to employ a deblossoming spray under certain circumstances as a supplementary control measure.

Summary

Results from deblossoming sprays may vary greatly according to variety of apple, climate, date of application and thoroughness of spraying. A pink spray of 2, 4-dinitro-6-cyclohexylphenol with oil emulsion, or 4, 6-dinitro-ortho-cresol either alone in water or with oil emulsion, destroyed a considerable number of fruit spurs when used at concentrations high enough to produce satisfactory killing of Jonathan and Grimes' Golden apple blossoms. Low concentrations of these substances, however, evenly thinned the crop without obvious spur injury. So far no chemical has been demonstrated capable of completely destroying apple blossoms without the likelihood of serious injury to fruit spurs.

In codling moth control the importance of deblossoming sprays or other means of crop removal appears to depend on the percentage of larvae in an orchard that live two winters before emerging as moths and upon whether or not the codling moth can survive on tissue other than fruit. Deblossoming McIntosh, Delicious and Wealthy apple trees with a tar-oil spray and subsequent removal of any developing fruit did not prevent heavy infestation by codling moth the following year in a two-generation area of the Okanagan Valley.

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CRYOLITE VERSUS LEAD ARSENATE FOR CONTROL OF CODLING MOTH *

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In 1939, cryolite was recommended for late codling moth spray applications in the interior of British Columbia. The purpose of the recommendation was to avoid heavy deposits of lead arsenate. A number of growers who have not accomplished satisfactory control of the codling moth since that time have blamed cryolite for their failure. Their distrust of cryolite has been increased by the appearance of the diluted spray mixture, as it resembles muddy water rather than spray material. Then too it leaves a less obvious deposit than lead arsenate. But the chief reason for unfavorable opinion results from the time of application, since it is more difficult to prevent codling moth entries during July when cryolite is used than during May and June when lead arsenate is applied. Furthermore, for every larva attempting to enter the fruit in May or early June, there may be twenty-five or more attempting to enter in July and August. A review of the investigations that serve as a basis for the cryolite recommendation will therefore be timely.

First it will be well to examine some of the work that has been done with cryolite in the neighboring state of Washington. This is summarized in Table I.

* Contribution No. 2221, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

* Reset and reprinted, with slight changes, from "Country Life in British Columbia" [Vernon, B.C.] 27 (2): 23 April 1943, through the kindness of Charles A. Hayden, Editor and Manager.

TABLE I

Codling Moth Infestation Following Use of Cryolite and Lead Arsenate In Washington State

	Per Cent Infested Fruit or Worms per 100 Fruits		
Year	Cryolite	Lead Arsenate	Reference
1928-9	24.7 (Fish oil sticker)	24.1 (2 yr. ave.)	Newcomer & Carter
1932	28. (Fish oil sticker)	34. (2/3 conc. only)	Webster et al.
1935	7.2 (Non-inverted oil mixture)	5.8 (inverted oil mix)	Unpub. records, Wash. Exp. Sta.
1936	24. (Non-inverted oil mixture)	12. (inverted oil mix)	Unpub. records, Wash. Exp. Sta.
1937	8. (Inverted oil mixture)	14. (inverted oil mix)	Marshall et al.
1938	74. (Inverted oil mixture)	121. (inverted oil mix)	Marshall et al.

In the Washington investigations, which were continued intermittently from 1928 to 1938, cryolite and lead arsenate gave approximately similar results on four occasions; cryolite appeared the more effective twice, while lead arsenate appeared the more effective once. The differences are such as might occur in separate experimental plots sprayed with same material, since with inverted mixtures in particular, the nature of the solid insecticide is by no means the only factor that plays an important part in the effectiveness of the resultant spray residue. For example, in 1936 the cryolite particles in the oil-cryolite-soap mixture remained water-wetted, while the lead arsenate particles in the corresponding lead arsenate mixture became oil-wetted. The lead arsenate gained greatly in effectiveness thereby.

In British Columbia, cryolite was first compared with lead arsenate for codling moth control by B. Hoy of the British Columbia Horticultural Branch, Kelowna, in 1936. A great deal of work has been done with it since that time.

In the British Columbia experiments, all infestations were recorded as per cent wormy fruit. In no instance was there a pronounced difference in the results from the two materials. Reduced to averages, the infestations are: cryolite 6.1 per cent and lead arsenate 5.7 per cent infested fruit. Granting the suspicion with which averages should be viewed, the difference is no greater than would be expected if in each instance both plots had been sprayed with the same material. With one exception casein-lime spreader was the adjuvant.

It is worth mentioning that trees at East Kelowna, sprayed with cryolite-casein-lime throughout the season were, at the end of the third year, no more heavily infested than the adjoining trees sprayed with lead arsenate-casein-lime each season.

There has been some speculation as to whether synthetic cryolite of United States manufacture and natural cryolite are equally effective. These materials have differed somewhat in fluorine content. An investigation of effectiveness was conducted at East Kelowna and the records are assembled in Table III.

TABLE II.

Codling Moth Infestation Following Use of Cryolite and Lead Arsenate in British Columbia*

Year	Per Cent Infested Fruit	
	Cryolite	Lead Arsenate
1936	1	1
1938	2	1
1939	16	17
1940	9	9
1940	13	12
1941	9	10
1942	4	3
1942	5	4
1942	3	2
1942	8	6
1942	1	3
1942	5	4
1942	2	2
1942	8	6

* Figures for 1936 and 1938 from unpublished records, B. Hoy, B.C. Dept. of Agriculture, Kelowna; the remainder from records of the Dominion Entomological Laboratory, Vernon.

TABLE III.

Comparison of Effectiveness of Natural Cryolite and Synthetic Cryolite

Year	Per Cent Infested Fruit*	
	Natural Cryolite	Synthetic Cryolite
1940	9	13
1941	9	22
1942	4	1
1942	3	2
1942	5	5
1942	8	8
1942	2	2
1942	3	3
1942	12	7

* The first seven comparisons from the records of the Dominion Entomological Laboratory, Vernon; the last two, from unpublished records of B. Hoy, B.C. Dept. of Agriculture, Kelowna.

Nine direct comparisons are available from this work. With three exceptions, one of which favors one product, two the other, differences are slight to nil. Averaged infestations, i.e., 6.1 per cent wormy fruit for natural cryolie and 7.0 per cent for synthetic cryolite, support the opinion that there is no essential difference in the effectiveness of the two products. The probable reason for the much higher infestation of the synthetic cryolite plot in 1941 was the greater population in this plot resulting from the high infestation of the previous season, when other spray materials had been used.

Summary

(1) Extensive investigation in Washington and British Columbia under arid or semi-arid conditions, has indicated that cryolite and lead arsenate are for practical purposes, equally effective in codling moth control. This holds whether the two compounds have been used with oils or with casein-lime spreader.

(2) Natural cryolite and synthetic cryolite have proved equally satisfactory.

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Note on Trachoma falciferella Wlshm. (Lepidoptera: Plutellidae)

This insect was not uncommon on orchard trees some years ago but is comparatively scarce today, owing no doubt to the heavy applications of arsenicals used for codling moth control, which have had a repressive effect upon a number of orchard pests. Choke cherry (**Prunus demissa** Nutt.) is its native host. Larvae were taken at Vernon, B.C., in 1931, feeding upon the terminal growth of apple and pear. The leaves are partially skeletonized and drawn together with a few silken threads to form a frail nest, within which the caterpillars remain concealed until they are disturbed. They then become exceedingly active and move over the leaf surface in a series of rapid snake-like motions.

Mature larvae measure 11-12 mm. in length, and are strongly fusiform in outline. The general colour is pale green tinged with yellow. Head pale with no markings. Dorsum pale green, with the intersegmental areas yellowish. There is a well-defined, narrow, whitish line on each side of the dorsum; these lines commence on the second thoracic segment and continue to the anal segment. Thoracic feet pale brown; prolegs concolorous with venter; the anal prolegs are extended at a wide angle with the body when the larva is at rest.

Eleven larvae which pupated between May 16 and June 13, produced adults from July 9 to 19. The pupa is formed within a silken cocoon composed of two parts: an exterior web of filmy construction and open texture, within which is a smaller case containing the pupa. The pupa, which is pale green in its earlier stages, becomes pallid and transparent prior to the emergence of the adult. —E. P. Venables, Vernon, B.C.

THE ENIGMA OF TICK PARALYSIS [1]

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Introduction

The object of this paper is to bring together observations on a series of tick paralysis experiments that have been conducted at the Livestock Insect Laboratory of the Dominion Department of Agriculture, Science Service; to compare them with the forms of tick paralysis that occur in other countries, and by these comparisons to clarify our impressions regarding the true nature of the disease. These experiements, often negative and at times apparently producing contradictory results, at least do emphasize the fascinating mystery of one of British Columbia's main livestock pests, the wood tick, *Dermacentor andersoni* Stiles.

Tick paralysis in British Columbia is a flaccid ascending motor paralysis that may be produced in livestock or humans by the feeding on them of one or more female ticks of the species *D. andersoni*. The symptoms do not occur until about the sixth day after the tick has attached, and progress from then on until the tick drops off replete, or is removed, after which there is usually a rapid recovery within half to two or three hours. Death may ensue if the respiratory center becomes paralysed before the tick leaves the host.

Tick paralysis also occurs in Australia, where man, sheep, dogs, pigs, cats and poultry have been reported by Ross (1935) as victims of *Ixodes holocyclus* Neumann, and in South Africa, where sheep have been recorded by Rensburg (1928) as having been paralysed by *Ixodes pilosus* Koch. Clark (1938) has also recorded paralysis in the same host, caused apparently by the African tick *Rhipicephalus evertsi* Neumann. In Yugoslavia, Mlinac and Oswald (1936) (1937) have described tick paralysis in ruminants, the vectors being *Hyalomma aegyptum* L. (Neumann), and *Boophilus calcaratus balanicus* (Minning). The symptoms produced by these foreign species are in a general way similar to those of the disease in this province. In America the disease is confined almost entirely to the ranching areas of British Columbia, and although the causative tick is just as abundant in southern Alberta as well as in Montana and other states to the south, tick paralysis is relatively scarce there.

Although considerable speculation on the etiology of American tick paralysis has been advanced, the fundamental cause of the symptoms still remains as much of a mystery as ever. It would seem that no theory attempting to explain tick paralysis has been put forward without arousing conflicting evidence.

Theories As to Cause of Paralysis

Briefly and in order of their probable validity, the main theories as to the cause of paralysis are here set forth.

1. *Paralysis of the nervous system by a toxin introduced by the feeding tick.*

This is the most generally accepted theory. It is substantiated by the fact that there is an almost immediate recovery following the removal of the tick, possibly due to the cessation of further injections of toxin. Also in support of this theory, assuming that Australian tick paralysis is similar to the British Columbia form, are the experiments conducted by Ross (1935). He found that the salivary glands of *Ixodes holocyclus*, ground and injected into mice, produced symptoms similar to those caused by the ticks feeding on dogs. The Australian disease, however, differs from that in Canada in that the paralysis appears to be more often fatal, and according to Ross (1934) may not even become ap-

1. Contribution No. 2260, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

parent until *after* the causative ticks are removed. Opposed to the toxin theory are the facts that not all British Columbia ticks appear to be capable of producing paralysis, and that animals capable of being paralysed by a single tick under ideal conditions can tolerate several dozen fast feeding ticks with no ill effects—a number that surely would inject far more poison than the most virulent individual tick. Ross (1935) makes no mention of *holocyclus* varying in its power to produce paralysis, other than stating that dogs were less frequently paralysed by large numbers than by single females. This would probably be due to individual resistance in the animals, for it would appear from his infesting experiments with laboratory animals that the symptoms of paralysis become increasingly severe with heavier infestations.

2. *Infection of host by some tick-borne agent.*

This is suggested by the fact that only ticks in certain territories (British Columbia as compared with Montana for example) and of these, only certain individuals, apparently are capable of producing paralysis; and by the fact that a six day period, resembling an incubation period, elapses between the time when the tick attaches and the onset of paralysis. In the dozens of observations made at this laboratory, paralysis has never been observed in which this period is less than six days, or more than eight. In the case of Australian tick paralysis, this period may be shortened to four days. Rensburg (1928) in South Africa also observes the fact that only certain ticks are capable of producing paralysis. He states "one is inclined to accept the theory that an infected tick produces paralysis in an animal by slowly injecting into it a narcotic poison which was obtained by the tick in some way or other before it got on to that animal." Mlinac and Oswald (1937) in Yugoslavia, have succeeded in killing guinea pigs by injecting them with crushed and filtered eggs of the European paralysis-producing tick, *B. calcaratus balanicus*. These experiments, but for the fact that the egg emulsions did not contain pathogenic organisms, might have suggested the passage of an infective agent through the eggs of ticks. As it is, the results appear similar to the more recent findings in America where it has been discovered by Gregson (1941) and by Steinhaus (1942) that the eggs of *D. andersoni* contain elements that are toxic to guinea pigs. Opposing the infection theory is the rapid recovery upon the removal of the tick.

3. *Mechanical injury to host by tick feeding over nervous system.*

This theory is widely credited by ranchers who have observed that ticks usually congregate along the spines of paralysed animals. Unfed ticks being negatively geotropic naturally gravitate to this region, but it is well known as pointed out by Mail and Gregson (1938) that paralysis may ensue when the causative tick is attached to any part of the body.

Discussion

Discussing the first and most logical theory as to the cause of tick paralysis, it seems fairly evident that under certain conditions a female wood tick is able to inject a toxin into the blood stream of the host which will paralyse its motor nerves. It would also appear that this toxin is injected only immediately prior to the repletion and subsequent dropping of the tick, being perhaps some form of regurgitated fluid, or possibly a glandular secretion to aid in the release of the tick's mouth parts. Incidentally, it is not understood yet how a tick, so firmly attached to its host by its immovable hypostome teeth, is able to release itself at will when replete, or even before repletion as happens when the host dies and becomes cold. The paralysing toxin probably is readily destroyed by the host, which would account for the rapid abatement of paralysis when the tick is removed. It may even be possible that the host is sometimes sufficiently resistant to cope with

the toxin and thus escape paralysis entirely. This would obscure the fact that the tick might have been potentially capable of producing paralysis. While, as stated, paralysis usually is produced only by ticks on the verge of repletion, there are records of ticks only half or one third engorged having caused the symptoms. There is even a record of a lamb being paralysed when a close examination revealed no other ticks than a male.

Ross (1935) in Australia, killed mice by injecting them with crushed salivary glands of *I. holocyclus*. These experiments were repeated in the Kamloops laboratory with *D. andersoni* but the results were not the same. Even when several times as many glands as used by Ross were dissected from fast feeding ticks (frozen at the time of removal from host to prevent any possible deterioration of a labile toxin) and injected intravenously and subcutaneously into mice and lambs, and intraspinally into puppies, the results continued negative. Similarly abortive have been the attempts to produce paralysis in lambs by injecting into them the crushed bodies of ticks that have been known to have produced paralysis. The latter injections were made alongside other engorging females in case some causative virus was dependent upon the simultaneous presence of tick venom in the host animal for its survival.

That only certain ticks appear to be capable of producing paralysis is demonstrated by the fact that often a *series* of ticks, feeding at the same time, may not paralyse an animal. The theory of acquired immunity does not detract from this observation, since on several occasions the feeding of numbers of ticks on previously uninfested lambs, which obviously would have no such immunity, has produced no paralysis. Moreover, in British Columbia one attack of paralysis does not necessarily produce an acquired immunity to subsequent attacks. Ross (1935) tates that the Australian tick *I. holocyclus* may produce an acquired immunity, but that it is not inherited. Such a resistance has been produced experimentally in guinea pigs against early stages of *Dermacentor variabilis* by Trager (1939) and in fitches and guinea pigs against *I. texanus* and *D. andersoni* by Gregson (1942).

Whether an inherited immunity towards *D. andersoni* exists is debatable. It is the common belief of ranchers in British Columbia, as quoted by Mail (1942), that animals exposed for several years to attack by ticks do build up an immunity, so that later ticks attacking such animals do not feed so readily. Indirectly this may lessen the chances of paralysis by eliminating fast feeding ticks. A slowly built up and inherited immunity might explain why wild deer, mountain sheep and moose, though often heavily infested, never appear to be paralysed by ticks. Such an inherent resistance however, may not be wholly responsible for the slow feeding rate of certain ticks, as is shown by tests made on Vancouver Island sheep, untouched for generations by ticks, and on which a dozen of these parasites, in July, were unable to feed rapidly.

Individual host susceptibility to ticks has been noted on a few occasions. In one series of infestations fifteen of sixteen ticks engorged in seven days on one lamb, while the average feeding period on six other lambs was nine days, with fifty per cent of them dying before repletion. Ross (1935) has also noted a variation among hosts and states that certain individual dogs are more resistant to *holocyclus* than others.

Nevertheless, although the condition of the host may play a part in the varying rate of tick feeding, it is also a definite fact that a large degree of these variations are due to the tick. This has been demonstrated in experiments by Gregson (1937) where specimens of *andersoni* were observed to feed at different rates in close proximity, on the same host.

It would thus appear from the foregoing remarks that certain ticks, and only certain ticks, are capable of pro-

ducing paralysis; and that these are usually fast feeding individuals. The condition necessary for this rapid feeding seems to be physiological, and either inherent, or produced in the tick by external stimuli. Since in the unfed condition potential paralysis producing ticks cannot be distinguished from harmless ones, an attempt was made to approximate the percentage of virulent ticks in a locality where paralysis normally occurred. Fifty week-old lambs each were infested with a pair of ticks from the same vicinity. The experiment was a failure, in that none of the ticks fed fast and no paralysis resulted. Nevertheless, a week later, ticks of the same stock *all* fed rapidly and paralysed the lamb upon which they were caged. The lamb was from the same farm as the previously infested stock. The weather, slightly warmer at the time of the second infestation, could hardly account for this difference in feeding, as experiments have shown that varying external temperatures have no effect on the feeding rate of ticks on sheep. It was thought that perhaps very young lambs might have been more resistant to ticks and thus have accounted for the slow feeding rate on the fifty lambs, but similar tests a year later on ten ewes and their twin lambs showed the parasites to feed no more readily on adult sheep than on lambs.

Perhaps the greatest hope of progress towards an understanding of the primary cause of tick paralysis lies in the fact previously stated that this disease as a rule is produced only by fast feeding ticks. One observation may prove significant and afford a clue, and that is the progressive inability of ticks in British Columbia to feed readily with the approach of mid-summer and fall. This phenomenon which, as shown by Gregson (1937), appears to be due to an inability on the part of the tick to produce sufficient disturbance within the host tissues to liberate an adequate blood supply, will probably be found to be closely connected with some climatic condition. Gregson (1938) noted that when ticks were subjected to increasing doses of ultraviolet light, their feeding powers were stimulated. Smith and Cole (1941) conclude from their recent experiments that the length of day is an important factor in controlling the activity of hibernation of larvae and nymphs of *D. variabilis*, that long photoperiods are more favorable to activity than short ones, and gradually increasing photoperiods more favorable than gradually decreasing ones of even greater absolute length. Rowan (1929) has shown that the length of light-day has an important effect on the physiology of birds. Similar light experiments on tick hosts, in which sheep were subjected to decreasing photoperiods, have shown, however, that any effect produced in them does not influence the feeding rate of the tick. Nor, according to Carrick's (1940) experiments with hedgehogs, does there appear to be any relation between the ticks' feeding rate and the presence or absence of sex hormones in the blood of the host. This theory has been suggested by MacLeod (1932) and by Rowan and Gregson (1935).

Bruce (1925) states that it is claimed that more cases of paralysis develop when there is an extreme range between the maximum and minimum temperatures, and suggests that this might induce a healthier appetite in the gorging female. At the Rock Mountain laboratory of the U.S.P.H.S., it has been noticed also that ticks feed more readily when subjected to a series of cold temperatures prior to infesting.

Thus temperature as well as light—and perhaps even humidity and other conditions not yet understood—may enter into the picture of tick behaviour, and these even may not act as stimuli until they are varied from their usual intensity in such a way as to disturb the rhythm of the individual. Considering how nebulous is our conception of such possible forces produced by fluctuations or gradual changes of external conditions, and regarding the apparently contradictory

nature of the etiological evidence of tick paralysis, it will be seen that the fundamental mechanism of this disease is most intricate and perplexing.

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The Weevil Auletobius congruus (Walker) a Pest of Strawberries

In May, 1940, Mr. C. R. Barlow, Provincial District Field Inspector, drew my attention to serious damage being done to a strawberry patch at Salmon Arm, by a small dark weevil. Specimens of this insect were sent to Mr. W. J. Brown, of the Division of Systematic Entomology at Ottawa, who identified them as **Auletobius congruus** (Walker).

An examination of the patch on May 18 showed some damage over about four acres; on half an acre about 35% of the blossoms were destroyed. The weevils were seen to cut into the base of the blossoms, causing the flowers to wilt and die.

The owner of the patch had never seen this beetle on his strawberry plants before and it has not appeared since. Examination of the available literature shows no reference to this weevil as a strawberry pest, and its sudden appearance in injurious numbers in 1940 may be of interest. Professor G. J. Spencer has found adults feeding on the flowers of a native buttercup, **Ranunculus** sp., on the hills near Aspen Grove, B.C.—E. R. Buckell, Field Crop Insect Laboratory, Kamloops, B.C.

CULICOIDES GIGAS R. & H. AT VERNON, B.C. (Diptera:Ceratopogonidae). This species was recorded from the Kamloops district by Curtis (1941. Ent. Soc. Brit. Col., Proc. 37:19). At dusk on May 7, 1942, the flies were common at a small pond on the hill above Goose Lake, and adjacent to Gartrell's mine. They settled on the neck and arms, but did not bite. Specimens were identified by Mr. A. R. Brooks of the Division of Entomology at Ottawa.—Hugh B. Leech.

SOME RECORDS OF LONG-LEGGED FLIES FROM BRITISH COLUMBIA (Diptera: Dolichopodidae)

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In the course of collecting all orders of insects for the University of British Columbia over a period of 17 years, a number of families in various orders have now reached the point where there are enough specimens to constitute at least a skeleton list, upon which further collecting will hang a representative picture of species for this Province. A start has to be made sooner or later and when even a fragmentary list is available, it serves as an incentive for special collecting in that particular direction. I hope to be able to put out several of these preliminary lists each year from now onwards if I can get the material identified, although it seems a hopeless task for a lone worker to undertake. Even if such lists serve little purpose at the moment, they may stimulate some other members of this Society to adopt any family and to specialize in it.

The *Dolichopodidae* or Long-legged flies (not long-*headed* flies as Curran has them in his priceless monograph of the Diptera of North America) are mostly metallic-green, smooth flies, usually less than one-third of an inch in length, which are predaceous on smaller insects. Cell M and 1st M^2 are not separated by a cross vein and there is almost always a bend in vein M^1 towards R^{4+5} before it straightens out to reach the margin of the wing: this bend in M^1 is a good family characteristic.

The genitalia of the males is often adorned with long appendages which flutter pennant-like behind while the insects are in flight. These flies frequent the edges of woods or bodies of water; some species of the genus *Dolichopus* frequent spray-dashed rocks; the species of *Hydrophorus* occurs on the surface of small pools and on mud flats; those of *Hercostomus* occur chiefly on foliage, and species of *Neurigona* are found on tree trunks, chiefly of smooth-barked trees (Essig, and Curran). The tall grasses fringing alkaline pools and little lakes of the cattle ranges of the Dry Belt are good collecting sites for these flies, chiefly species of *Dolichopus*.

The list that follows is based on 132 flies, all, except two, of my collecting. I am deeply indebted to Dr. Fred C. Harmston of Logan, Utah, now Capt. F. C. Harmston of the Malaria Control Programme, Indianapolis, Indiana, for volunteering to identify these flies for me, especially in view of the fact that he undertook the work in the midst of his military duties and returned the specimens within ten days after receiving them; every collector who undertakes the identification of insects in the midst of his other duties will fully appreciate what this involves.

Dolichopus plumipes Scop.—Nanaimo Nicola.
D. bruesi Van D.—Sidney, V.I., Summerland.
D. nigricauda Van D.—Kamloops.
D. robertsoni Curran—Chilcotin.
D. renidescens M & B—Kamloops, Chilcotin.
D. obcordatus Ald.—Nicola, Kamloops, Chilcotin.
D. occidentalis Aldr.—Departure Bay (Nanaimo), Vancouver.
D. idahoensis Ald.—Nicola.
D. adaequatus Van D.—Kamloops, Chilcotin.
D. maculitarsis Van D.—Kamloops.
D. conspectus Van D.—Chilcotin.
Hercostomus tristis Lev.—Tofino, V.I
H. metatarsalis Thom.—Chapman.
Neurigona sp.—Chilcotin.
Melanderia mandibulata Aldr.—Skidegate.
Scelus monstrosus O.S.—Tofino, Nicola, Kamloops, Chilcotin.
S. avidus—Nicola.
Scelus sp.—Chilcotin.
Hydrophorus breviseta Thom.—Royal Oak (Victoria), Summerland.
Rhaphium sp.—Nicola.
Rhaphium sp.—Summerland, Kamloops, Chilcotin.
Parasyntormon occidentalis—Chilcotin.
There are apparently 2 new spp. of **Rhaphium.**

About 2,000 species of this family have been named to date. This preliminary list for nine localities of this Province includes twenty species in eight genera—the number of species being one-hundredth of the world's total. Without doubt further collecting, purposely for this family, will greatly add to this total, which shows that the *Dolichopodidae* are very well represented in British Columbia.

RECORDS OF SOME FLIES AND WASPS COLLECTED AT ROBSON, B.C.
(Diptera: Tabanidae; Hymenoptera)

HAROLD R. FOXLEE
Robson, B.C.

The following species were all collected by me at Robson, B.C. I am indebted to Dr. L. L. Pechuman for identifying the Tabanidae, and to Mr. H. D. Pratt for the names of the Hymenoptera.

DIPTERA

Tabanidae

Tabanus haemaphorus Mart.—30. VII. 39.
Tabanus laniferus McD.—21. VIII. 37; 24. VII. 38; 20. VII. 39.
Tabanus procyon O.S.—29. IV. 39; 21. IV. 40; 7. V. 40.
Tabanus rhombicus var. *rupestris* McD.—26. VII. 39.
Stonemyia californica Big.—10. VII. 37.
Silvius gigantulus Lw.—25. VI. 37.
Chrysops pertinax Will.—June to September.
Chrysops excitans Walk.—29. VI. 40.

HYMENOPTERA

Ichneumonidae

Trogus fulvipes Cress.—June 11, 12.
Hoplismanus pacificus Cress.—June 24.

Cryptinae

Acrorcius excelsus Cress. — July 16; Aug. 6.
Echthrus vancouverensis Brad. — April 24; May 23.
Cryptus altonii D. T.—May 24; Aug. 20.

Pimplinae

Rhyssa alaskensis Ashm.—July 9.
Rhyssella nitida Cress.—June 19.
Coleocentrus occidentalis Cress.—July 9.
Xorides harringtoni Roh.—Aug. 13.
Lissonota brunnea Cress.—Sept. 7.
Cylloceria occidentalis Cress.—Oct. 5.
Deuteroxorides borealis Cress.—Aug. 9.
Pimpla pedalis Cress.—April 11; Oct. 22.
Itoplectis obesus Cush.—Oct. 22.
Apechthis picticornis Cress.—Sept. 2.
Perithous pleuralis Cress.—July; August; September.

Tryphoninae

Diplazon pulchripes Prov.—Oct. 22.

Ophioninae

Campoplegidea vitticollis Norton.—Oct. 22.
Therion morio Fab.—June; July.
Cidaphus occidentalis Cush.—July 2.

Aulacidae

Neaulacus occidentalis Cress.—May 30; July 13.
Odontaulacus editus Cress.—May; June; July.
Pristaulacus montanus Cress.—July 2.

MARATHYSSA INFICITA WALKER AT OLIVER, B.C. (Lepidoptera: Phalaenidae). Mr. E. Peter Venables found an outbreak of this species in July, 1942. The only previous British Columbia record in the literature available is for Lillooet, without mention of a host plant.

On July 17 the chunky green caterpillars, close resembling sawfly larvae, were taken on sumac bushes (**Rhus glabra**) along the highway 4 miles north of Oliver. At the time only a few specimens were present, but there must have been thousands a little earlier, as for miles the sumacs were almost stripped of leaves. The caterpillars were given to the Forest Inset Survey unit, and identified by M. W. C. McGuffin of Ottawa.—Hugh B. Leech.

MISCELLANEOUS RECORDS OF BEETLES IN BRITISH COLUMBIA

(Coleoptera: Hydrophilidae, Elateridae, Buprestidae, Lathridiidae, Chrysomelidae, Curculionidae).*

HUGH B. LEECH

Dominion Forest Insect Laboratory, Vernon, B.C.

Helophorus nitidulus LeConte. This little black species may be separated from others in the genus by the almost straight sulci on its smooth, inflated pronotum. It was described from Eagle Harbor, Lake Superior, and is known from Indiana and Manitoba. British Columbia specimens before me are: Salmon Arm, 1 male from an ephemeral pond in the woods, 7. V. 39, and a pair from Norton's pond, 24. V. 39 (Hugh B. Leech); Nation River area, 1 male, 25. VI. 40 (Geof. B. Leech).

Ludius glaucus Germar. These blackish click beetles occurred in thousands on the flower heads of a species of *Lupinus* at Vernon, B.C., during late May and early June, 1942. They were eating the buds and partially opened flowers, hollowing out irregular cavities in the sides and ends. In 1911 (Ent. Soc. Brit. Col., Proc. 1: 9) Venables reported this species at Vernon (as *Corymbites inflatus)*, noting that the beetles congregated on lupine stems, and that they damaged newly planted fruit trees by eating out the buds in early summer. Brittain (op. cit. 2: 14. 1913) also mentioned damage to young apple trees, as did Ruhmann (7: 8. 1915).

Chrysophana placida LeConte. In our "Proceedings" 27:6-10, issued March 1931, G. J. Spencer gives 7 records of beetles emerging from prepared timber in buildings. The following note adds another species to the list.

At Salmon Arm, B.C., on April 5, 1932, a fresh hole was noticed in the outer wall of the north end of my father's barn. Careful digging disclosed a live *placida*, which had almost gnawed its way out from the pupal burrow. The barn was built of seasoned Douglas fir lumber in 1920, and was painted that year or the next.

Cartodere ruficollis Marsham. Taken in 1932 at Salmon Arm, B.C., where it was common on the north end of my father's barn. The species was first found on February 28, by which date various small beetles were coming out of hibernation, and a few such as *Cercyon*, flying. On April 5 the *Cartodere* were most numerous in the hayloft, where they were crawling on the floor in a dust of crushed alfalfa leaves and seeds. A single specimen had one elytron white, the other black as usual.

Donacia idola Hatch. This species was described from Chase Lake, a sphagnum bog in Snohomish County, Washington (1939. Pan-Pacific Ent. 14 (3):110-112). On July 19, 1931, I took a series of *idola* on grasses and sedges around a pond on Seymour Mountan, a few miles from Vancouver, B.C. The pond is in a meadow beside the cabin built by members of the Alpine Club of Canada.

Chrysolina vidua Rogers. Adults, eggs, and larvae in all stages, were common on a wild aster *(Aster multiflora* Ait. Det. Prof. J. Davidson) along the Commonage road at Vernon, B.C. during the first half of June, 1942. No host plant was listed by Van Dyke, in his review of the nearctic species (1938. Bul. Brooklyn Ent. Soc. 33 (2): 45-58).

Barypeithes pellucidus Boheman. The first British Columbia record for this little weevil was from Victoria, B.C., 1936, by Harry Andison and W. Downes (see Brown, Canadian Ent. 72(4):67). In June 1941 I found the adults common on mature strawberry fruits in a small

*Contribution No. 2245, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Ont.

garden at 504 James St., Vernon, B.C.

The beetles are 3 to 3.75 mm. long, shiny piceous or rufescent, with antennae, legs and abdomen reddish; the dorsal vestitute is long and sparse. Easily separated by its smooth, evenly punctuate pronotum, from the larger *Brachyrhinus ovatus* L.

Gymnetron tetrum Fab. This squat little gray-haired weevil is common on mullein *(Verbascum)* in the eastern United States and Canada, and also in parts of Europe and Siberia. It has been reported from eastern Washington. I have found it numerous at Vernon (1940) and Osoyoos (1941). In winter and early spring the adults may be found hibernating under the rosette of basal leaves on dead mulleins; the larvae are said to live in the seed pods.

SOME FOOD PLANTS OF LEPIDOPTEROUS LARVAE. List No. 9

J. R. J. LLEWELLYN JONES
Cobble Hill, B.C.

An asterisk (*) denotes that the species has been mentioned in these lists previously, and that the information now presented is either additional, or is an amplification of what has already been reported.

Records in this list are supplied by the author.

Rhopalocera

* *Basilarchia lorquini burrisonii* Mayn. Hardhack *(Spiraea douglasii* Hook.).

Heterocera

* *Acronicta (Apatela) funeralis* G. & R. Willow *(Salix scouleriana* (Hook.) Barr.), ornamental species of willow, Carolina poplar, and garden species of plum.

* *Acronicta illita Sm.* English oak *(Quercus robur)*, alder *(Alnus rubra* Bong.), and ornamental crab apple *(Pyrus malus floribunda)*.

* *Acronicta radcliffei* Haw. Hyslop crab apple and garden species of plum.

* *Acronicta distans dolorosa* Dyar. Alder *(Alnus rubra* Bong.).

* *Amphidasis (Lycia) cognataria* Gn. Ocean spray *(Spirea discolor* Pursh.).

* *Halisidota maculata angulifera* Wlk. Hardhack *(Spiraea douglasii* Hook.), June-berry *(Amelanchier florida* Lindl.), willows *(Salix hookeriana* Barr., *Salix scouleriana* (Hook.) Barr.).

* *Hyphantria textor* Harr. Willow *(Salix lasiandra* Benth.).

* *Malacosom disstria erosa* Stretch. Alder *(Alnus rubra* Bong.).

* *Malacosoma pluvialis* Dyar. Wild cherry *(Prunus emarginata* Dougl.).

* *Nadata gibbosa oregonensis* Butl. Spanish chestnut (Species of *Castanea)*.

* *Pheosia portlandia* Hy. Edw. Willows *(Salix lasiandra* Benth., *Salix hookeriana* Barr., *Salix scouleriana* (Hook.) Barr.), poplar *(Populus trichocarpa* T. & G.), and aspen *(Populus tremuloides* Michx.).

* *Pseudothyatira cymatophoroides* Gn. English hawthorn *(Crataegus oxyacantha* L.), and garden species of plum.

Scoliopteryx libatrix L. Willows *(Salix lasiandra* Benth., *Salix scouleriana* (Hook.) Barr.), black poplar *(Populus trichocarpa* T. & G.), lombardy poplar.

* *Schizura unicornis* A. & S. English hawthorn *(Crataegus oxyacantha* L.), garden species of plum.

FIELD OBSERVATIONS ON THE FOREST TENT CATERPILLAR, MALACOSOMA DISSTRIA VAR. EROSA STRETCH

GEORGE A. HARDY

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The following account is based on field notes made in the course of a Provincial Museum field trip in the vicinity of Lac la Hache, Caribou District, British Columbia.

A very noticeable feature of the landscape was the devastation wrought by the forest tent caterpillar on the deciduous trees and shrubs. The extent of the territory affected was not fully determined. My notes record evidence of its work from 100 Mile House to Williams Lake, a distance of over 60 miles along the highway. Side trips that took us off the main road always revealed its presence, so that it is probable that the outbreak extended laterally for an equal distance, an area of at least 50 square miles *.

The aspen trees *(Populus tremuloides* Michx.) were completely defoliated with only isolated exceptions. When no aspen leaves were left the hungry hordes then attacked the adjacent shrubs, willow, alder, birch, dogwood and rose. The odd spectacle of roses apparently suspended in mid-air became a common one, for the blossoms were left untouched. One of the willows, *Salix exigua* Nutt., presented a strange combination of juvenile and adult characters in the leaves. In the young stage the leaves are silvery pubescent, becoming glabrate in age. When the old leaves were consumed by the caterpillars, the plant put forth a secondary growth so that the silver and green were side by side in those instances where the older leaves still remained. A noticeable exception was seen in the bushes of the buffalo berry, *Shepherdia canadensis* Nutt., and the silverberry, *Elaeagnus argentea* Pursh., which though growing with the other herbage attacked, were completely ignored by the caterpillars as a food substance, though freely employed as a support for their cocoons. According to reports of the local inhabitants, the preceding year, 1941, witnessed an even more severe attack. At the height of the outbreak the fence posts and wires were continuous sheets and ropes of caterpillars. Their crushed bodies made the railroad metals at times too slippery to permit the locomotive wheels to obtain traction.

By June 24, 1942, the date of our arrival in the vicinity, the caterpillars were nearly all fully grown; already the bare wintry look of the aspen trees was rendered still more striking by the clusters of white cottony cocoons that covered every twig, giving a very effective simulation of snow, especially when viewed against a background of sombre fir trees. The cocoons were by no means confined to the food plants; everything in the neighborhood supported them. Juniper, fir and even the buffalo berry bushes were laid under tribute for their support, not to mention our tent and personal belongings. For the first few days the full-fed larvae were wandering everywhere, into and over everything, a steady stream continually ascended table, chair and other legs; even the surface of the lake bore numerous wriggling caterpillars, extending in some places far out from shore. Many never reached the cocoon-spinning stage, as a result of attack by parasites either bacterial or insect in origin; scores of empty larval skins were draped over the bushes or flattened on the tent roof and other objects in the vicinity.

At the beginning of July, an unusual and increasing number of Brewer's blackbirds and bluebirds were noticed in the aspen wood near which we were en-

* Mrs. Elsie Bowyer reported from Salmon Valley, about 15 miles north of Prince George, B.C., that in 1942 tent caterpillars were extremely numerous, and invaded her young orchard "in two-feet wide streams from several directions, in the manner of army worms." Ed.

camped, particularly at dawn and dusk. At the same time quantities of large yellow dipterous maggots were found in and among our pots and pans. This discovery gave a clue to the intermittent tattoo that had been heard on the tent roof during the night and early morning. Investigation proved the sound to be due to these maggots falling from the cocoons spun up in the over-hanging branches. Further observation led to the discovery that the blackbirds and bluebirds were feeding on the abundant and easily procured maggots before they could burrow out of sight into the ground for pupation. The blackbirds were occasionally seen to rip open a cocoon, possibly having first seen a maggot wriggling to get out, as no evidence was obtained to prove that they were deliberately consuming the pupae of the moth.

A census was taken of the cocoons in order to ascertain what percentage contained parasitized pupae or larvae. One hundred were gathered at random and carefully examined and recorded. While it is obvious that one count cannot be taken as conclusive evidence for the whole district, it gives an idea as to what might be expected. Forty-four cocoons contained parasitized larvae, each inhabited by from one to five maggots of various sizes. Twenty-six pupae were parasitized in like manner. Thirty pupae were free of large dipterous maggots, although some of them were very feeble and lifeless.

Summed up, the result of examination demonstrated that in the case of those caterpillars that spun cocoons, 44 per cent were unable to pupate, 26 per cent contained parasites after reaching the pupal stage and the remaining 30 per cent appeared to be normally healthy although in a varying degree of vigour. Unfortunately no adults were reared from the pupae which were retained hence no figures are available as to the final effect of parasitism. Examination of cocoons in situ showed many of them with the round escape holes of the mature dipterous larvae, others bore evidence of being ripped open by the blackbirds, as previously observed.

Several adult dermestid beetles were taken or seen flying about the camp and while the preserved skins of drying mammals and birds no doubt had something to do with their presence, there is the possibility that they were attracted by the large numbers of dead and rotting *Malacosoma* larvae.

ON THE OVIPOSITION HABITS OF THE AUSTRALIAN COCKROACH, PERIPLANETA AUSTRALASIAE (FAB.)

G. J. SPENCER

Department of Zoology, University of British Columbia, Vancouver, B.C.

During the last week in November some years ago a firm of local grocers sent me a gravid Australian cockroach. The roach was placed in a glass-covered beechwood rearing box about 14″x10″ x3″; the box already contained a few domestic crickets with their food and shelter. It was observed for a few minutes daily during the next three months and its habits recorded; the following notes are extracted from these records:

Dec. 1. 10 a.m. carrying a partly extruded egg pod which was fully extruded by 12:30 p.m.

Dec. 3. Still carrying the egg pod.

Dec. 5. Pod deposited on the floor and later the same day partly devoured by the roach or by the crickets.

Dec. 7. 2 p.m. A 2nd pod was just appearing so the roach was removed to another similar cage which was butted up against a radiator for heat, and supplied

with a variety of powdered cereals, water from a partly plugged vial lying on the floor of the cage, and dried lean meat. Beyond a small tent-shaped piece of paper, there was no cover in the box.

Dec. 8. The egg capsule started the previous day had been deposited on the floor and had been eaten out by the roach which had probably eaten the previous one also.

Dec. 17. a.m. A 3rd capsule had been deposited overnight and had been completely covered in one corner of the box with shreds of wood fibre which the roach had torn off the smooth, dry, hard side of the box, and had cemented together with salvia. This gouging of fibres from the planed wood showed greater strength and sharpness of mandibles than one would expect to find in a cockroach. The cage was supplied with a petri dish of water with a flat wad of cotton batting in it to provide moisture. Cover for the insect was added in the form of a number of muddy grass roots with chopped-off stems and leaves.

Dec. 20. 10 a.m. A 4th ootheca just appearing. In the past 3 days the roach had twice covered up the 3rd pod with tufts of grass roots and had twice uncovered it again. The humidity in the cage was at saturation point. By 5:30 p.m. the 4th ootheca was almost completely extruded.

Dec. 24 From 11 a.m. to 3 p.m. carrying a 5th egg pod which was a light red colour instead of the usual dark brown.

Dec. 26. Either the 4th or 5th pod had been eaten so the remaining one was removed to another cage to see if the eggs would hatch. They did not.

Dec. 28. A 6th pod had been laid overnight and covered with a sloping shelter alongside the paper shelter, of grass and roots.

Jan. 2. A 7th pod was banked up in a sort of lean-to up against the previous one.

Jan. 5. An 8th pod was deposited overnight, was partly covered with grass and flour from the feed dish, and was placed in the corner alongside ootheca, No. 3.

Jan. 12. A 9th pod, placed with the Nos. 6 and 7, covered with an earthen coat.

Jan. 16. A 10th pod, besides the above, covered with foodstuffs, grass and earth. All these materials for covering had been carried two to three inches. Pod No. 8 was removed and examined and proved to be shrivelled up.

Jan. 23. The 11th pod, deposited overnight and covered with adobe alongside the above.

Jan. 28. Extruding a small pod.

Jan. 30. Pod No. 12, laid, not covered; eaten later the same day.

Feb. 8. Carrying a new pod, No. 13.

Feb. 9. Pod No. 13 deposited overnight, placed away from the others and covered with adobe.

Feb. 20. The 14th pod deposited alongside No. 13 on the floor, covered with adobe.

Feb. 28. Pod No. 15 deposited loose on the floor, not covered.

March 5. Carrying the 16th ootheca. Deposited it during the day and later covered it with adobe near Nos. 6 to 12.

March 10. The 17th egg pod, a very small one, was deposited and covered with adobe, at the hot end of the cage near the radiator, at the opposite side of the cage from all the others. Shortly after this the roach died. None of the eggs hatched.

We have here an unfertilized roach depositing 17 egg pods in exactly 100 days: she may have laid eggs before being confined in this cage. The egg laying averaged 1 pod every 6 days; most of them were covered with trash.

I find that the American roach also has this habit of covering her oothecae with trash and also of eating them now and then although supplied with an abundance of food and water.

AN OCCURRENCE OF SCUDDERIA FURCATA FURCATA BRUNNER, ON THE COAST OF BRITISH COLUMBIA (Orthoptera: Tettigoniidae)

J. F. DAVIDSON

Vancouver, B.C.

On October 11, 1937, two specimens of the Fork-tailed Bush Katydid, (*Scudderia furcata* Brunner) were taken in the Fraser River delta. Both specimens were caught on the trestle of the Canadian National Railway, where the line crosses the north fork of the Fraser River to Lulu Island. Since the insect was not immediately recognized as uncommon to this region, no further specimens were sought, but the following day, after identification, another trip to the vicinity was made.

Some search was made before any were found, but a low purring chirp led the party to a birch tree (*Betula occidentalis* Hooker) where close examination showed one of the green Katydids. It was almost indistinguishable from the leaf on which it was resting, and this, coupled with the fact that the chirping always seemed to be farther away than it actually was, accounts for the difficulty in finding the insect. After discovering the location of the singers, judicious sweeping of the lower branches yielded some twenty specimens of both sexes.

The distribution in this area appears to be very limited, since all of the insects were taken in a narrow belt extending about twenty-five yards on both sides of the railway, and within half a mile of the river. Whether or not they occur on the north bank of the river was not determined, since the railway bridge is usually kept open, and the north bank at this point is rather difficult to reach.

The distribution of this Katydid is of considerable interest because this finding of it practically on the sea-shore, extends the range right across the continent. Mr. Morgan Hebard records specimens from the following States: New Hampshire; Massachusetts; Rhode Island; New York; New Jersey; Pennsylvania; Maryland; District of Columbia; Virginia; North Carolina; South Carolina; Georgia; Florida; Michigan; Wisconsin; Ohio; Indiana; Missouri; Kentucky; Tennessee; Alabama; Louisiana; South Dakota; Nebraska; Kansas; Arkansas; Oklahoma; Texas; Idaho; Washington; Oregon; and California; in all thirty-two states, and in Canada from Ontario; Quebec, and British Columbia. Mr. Ronald Buckell of Kamloops informs me that he has collected it in British Columbia from: Kaslo, Vernon, Salmon Arm, Enderby, Oliver, Creston, Penticton, Osoyoos and Lillooet.

This makes its distribution practically as widespread as any one of the ubiquitous *Acridiinae* although its altitudinal distribution may not be so great. But whereas such specimens as *Camnula pellucida* (Scudder) and *Melanoplus mexicanus* (Saussure) are freely flying and swarming forms, this insect is secretive, very local in distribution and frequently nocturnal. This extraordinarily wide range means therefore that the species is either of very great antiquity or indulges in hitherto undetected flights of some distance, probably at night, or is distributed by man in some way, perhaps in the egg stage. In this instance, since the range of occurrence was restricted to the above-mentioned area bordering the railway, it is quite conceivable that the original parent or parents, arrived as adults via some open form of railway car.

The question of its food in the locality where I found it seemed worthy of investigation, so the stomach contents were examined microscopically. The finely comminuted plant material contained an unusual number of stomata per unit

area, and many peculiar club-shaped bodies occurred everywhere. The type and distribution of the stomata indicated a marsh or aquatic plant, and the absence of stomata on one of the leaf surfaces indicated a floating water plant. The leaves of the Yellow Pond Lily (*Nymphaea polysepala* Engelm.) were examined and were found to correspond in having the same stomatal distribution, and in having club-shaped papillae on the lower surface, identical with those found in the stomach of the insects. Thus it is logical to assume that this plant constituted the food of the Katydid at the time of capture. The birch trees were apparently merely resting places, and the insects must fly down to feed on the aquatic plants, probably at night.

INSECTS ACTIVE THROUGHOUT THE WINTER AT VANCOUVER, B.C. PART II: LISTS OF THE ORTHOPTERA, DERMAPTERA, HOMOPTERA, HEMIPTERA, DIPTERA, AND HYMENOPTERA.

RAY E. FOSTER

1575 Kamloops St., Vancouver, B.C.

This report constitutes a partial list of insects collected during the period November 8, 1939 to March 28, 1940 at Vancouver, B.C. It supplements the list published in Part I of this series (Foster, 1942), and completes that portion of the study which will serve as a basis for the ecological relationships now being prepared for publication.

In Part I, lists of the Coleoptera and Neuroptera were given and brief mention was made of the Thysanura and Collembola. To these four orders, eight more are added at this time, bringing the number of orders collected during the winter survey to 12. The Lepidoptera and Corrodentia are not given specific consideration.

ORTHOPTERA

LOCUSTIDAE

Acrydium brunneri Bolivar

DERMAPTERA

FORFICULIDAE

Forficula auricularia Linn.

HOMOPTERA

CERCOPIDAE

Philaenus leucopthalmus Linn.

CICADELLIDAE

Balclutha manitou (G. & B.)
Typhlocyba commissuralis Stal.
Typhlocybini sp.
Dikraneura sp. Very common.
Helochara communis Fitch.
Idiocerus downesi B. & P. Very common.

PSYLLIDAE

Specimens of frequent occurrence. No specific determinations made.

APHIDIDAE

Myzus ligustri? Mosley. Taken in immense numbers in March.

HEMIPTERA

MIRIDAE

Lygus pratensis var. *oblineatus* Say

ANTHOCORIDAE

Anthocoris antevolens White

NABIDAE

Nabis roseipennis Reut.
Nabis alternatus Parsh.

LYGAEIDAE

Ischnorrhynchus franciscanus Stal. Very common.
Lygaeus kalmii subsp. *kalmii* Parsh.

PENTATOMIDAE

Elasmostethus cruciatus Say Very common.
Podisus modestus Dall.
Banasa sordida Uhl.
Apateticus crocatus Uhl.

DIPTERA

AGROMYZIDAE

Phytomyza spp.

ANISOPODIDAE

Anisopus fenestralis Scopoli.

BIBIONIDAE

Bibio tristes Will.

BORBORIDAE

Borborus equinus Fallen
Leptocera sp.
Sphaerocera pusilla Fallen
Scatophora carolinensis Desv.

CECIDOMYIIDAE

Monardia canadensis Felt.
Phytophaga sp.

DIXIDAE

Dixa sp.

DOLICHOPODIDAE

Hydrophorus pensus Aldrich
Hydrophorus breviseta? Thomson
Hydrophorus innotatus Lw.

DROSOPHILIDAE

Drosophila inversa Walker
Drosophila sp.

EMPIDIDAE

Rhamphomyia sp.
Hydrodromia stagnalis Hal.

EPHYDRIDAE

Scatella spp.

HELOMYZIDAE

Tephrochlamys sp.
Oecothea fenestralis Fallen
Suillia limbata Thomson

LONCHOPTERIDAE

Lonchoptera dubia Curran

MUSCIDAE

Spilaria lucorum Meigen
Musca domestica L.
Scatophaga stercoraria L. Very common.
Scatophaga furcata Say. Very common.
Scatophaga sp.
Quadrula lucorum Fallen
Anthomyiine

MYCETOPHILIDAE

Bolitophilinae

Bolitophila dubiosa Van Duzee
Bolitophila montana Coq.

Sciophilinae

Dziedzickia (*Syntemna* of Joh.). Undescribed species.
Mycomyia terminata Garrett
Mycomyia sigma Joh.
Mycomyia spp. Females and defectives.

Mycetophilinae

Boletina "tricincta" No. 501 of Joh.
Boletina spp. Females and defectives.
Coelosia lepida Joh.
Cordyla. Undescribed species
Exechia. Undescribed species near *E. aviculta* Shaw.
Exechia clepsydra Fisher
Exechia fusca Mg. (*fungorum* Deg. of Joh.) Very common.
Exechia spp. Females and defectives.
Phronia sp. Female.
Phronia (*Telmaphilus* of Joh.) *tenebrosa?* Coq.
Phronia. Undescribed species near *P. insula.*
Rhymosia. Undescribed species near *R. seminigra* Sherman.
Allodia sp. Defective.
Mycetophila fungorum Deg.
Mycetophila spp. Females.
Mycetophila mutica Lw.
Mycetophila fenestrata Coq. Very common.
Mycetophila lassata Joh.
Mycetophila maculosa Guthrie.
Mycetophila fatua Joh. Very common.

Sciarinae

Sciara (*Neosciara*). Undescribed species

PHORIDAE

Megaselia sp ?
Triphleba pacyneura Loew
Triphleba varipes Malloch
Triphleba sp.

PIOPHILIDAE

Piophila nigricoxa Mel. & Sp.

PSYCHODIDAE

Pericoma spp.

SYRPHIDAE

Eristalis tenax Linn.
Epistrophe mentalis Will.
Melanostroma fallax Curran
Melanostroma stegnum Thoms.

TACHINIDAE

Gonia frontosa Say
Argenteopalpus signiferus Walker
Cyrtophleba nitida Curran
Calliphora erythrocephala Meigen

TETANOCERIDAE

Dictya sp.

TIPULIDAE

Limoniini

Limonia (*Rhipidia*) *maculata* Meigen

Pediciini

Pedicia (*Tricyphona*) *diaphana* Doane
Pedicia (*Tricyphona*) *vitripennis* Doane

TRICHOCERIDAE

Trichocera columbiana Alexander. Very common.
Trichocera colei Alexander
Trichocera sp., near *T. annulata* Meigen
Trichocera sp.

HYMENOPTERA

Andrena (*Andrena*) sp. Traces to *A. harveyi* Vier. In Viereck's synopsis (Viereck, 1904).
Andrena (*Trachandrena*) sp. Traces to *A. salicifloris* Ckll. var. *a*, in Viereck's synopsis.
Andrena (*Pterandrena*) sp. Traces to couplet 8 in Viereck's synopsis.
Halictus sp. Traces to *H. crassiceps* Ellis in Sandhouse's key (Sandhouse, 1924).
Ophion sp.
Gelis keeni Hgtn.
Hemiteles ?
Aperleptus sp. Probably undescribed species.
Plectiscus orcae? Ashm.
Orthopelma californicum Ashm.
Orthocentrus sp.
Phaeogenes sp.
Pachynematus sp.
Pachynematus sp.
Dolerus neoaprilis kenowi Macq.
Xenotoma ?

The above specimens, with the exception of the following types, are in the collection of the Department of Zoology of the University of British Columbia. Specimens of *Sciara (Neosciara)* were retained by Dr. F. R. Shaw. All other

undescribed Mycetophilidae are in the possession of Dr. Elizabeth Fisher. Undescribed Hymenoptera are in the Canadian National Collection, Ottawa, Canada.

Acknowledgments—I am indebted to the many persons who assisted in the identification of the insects obtained during the course of the survey: Dr. G. S. Walley, Dr. O. Peck, Dr. Carl Atwood, Dept. of Agriculture, Ottawa, Ont. (**Hymenoptera**); Dr. C. F. Adams, Jefferson City, Missouri, (**Chironomidae**); A. R. Brooks, Dept. of Agriculture, Ottawa, (**Diptera**); Mr. Geo. Steyskal, Detroit, Michigan, (**Diptera**); Dr. C. H. Curran, New York, (**Diptera**); Dr. E. P. Felt, Stamford, Conn., (**Cecidomyiidae**); Mr. W. Downes, Victoria, B.C., (**Hemiptera, Homoptera**); Mr. R. Glendenning, Agassiz, B.C., (**Aphididae**); Dr. E. G. Fisher, Roland Park, Maryland, (**Mycetophilidae**); Dr. C. P. Alexander, Amherst, Mass. (**Tipulidae**); and Dr. F. R. Shaw, Amherst, Mass., (**Sciaridae**).

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IN MEMORIAM

George O. Day, F.E.S

On February 5th, 1942, there passed away at the age of 88 one of our Society's oldest and most valued members. George O. Day came to British Columbia from England in 1905 and made his home at Duncan, Vancouver Island. Prior to coming to this Province he was manager of Parr's Bank at Knutsford, Cheshire, retiring in 1905. It has been possible to gather only scanty information regarding his early life but we are informed that he was a Freeman of the city of Chester, an honour only likely to be bestowed for outstanding public service. He was a fellow of the Royal Entmological Society. Apparently he had been active in the study of other sciences also and we learn with interest that his tutor in botany was the Rev. Charles Kingsley.

Mr. Day became a member of the Entomological Society of British Columbia on April 19, 1906, and the 7th annual meeting was held at his house in April, 1908. He was elected vice-president in 1912 and was president from 1913 to 1915. His particular interest was in Lepidoptera and he had a fine collection of the Vancouver Island species. This collection is remarkable for the beautiful mounting and condition of every specimen, for its maker could tolerate nothing but the best. He had originated a method of setting Lepidoptera which was largely responsible for the beautiful condition of the specimens. The wings were held in position on the setting board by means of slips of glass hinged to the edges of the board, the weight of the glass in most cases being sufficient to hold the wings in place until dry. This collection is now in the possession of the Shawnigan Lake boy's school at Shawnigan, B.C., to which it was bequeathed, as was also a collection of British butterflies and moths, brought by Mr. Day from England, containing examples of nearly every British species.

The late Mr. Day was noted for his genial, kindly disposition, courtesy and friendliness. Visiting entomologists never failed to receive a warm welcome at his beautiful home "Sahlatston" at Duncan,

and he was always eager to show his collection and enter into discussions relating to his favourite hobby. Generous in giving specimens to others and always willing to help beginners, he was perhaps the best type of amateur. He was a regular attendant at the annual meetings of the Society until infirmity due to advancing years compelled him to cease active participation. In his passing another link with the early years of the Society has been severed and those who had the privilege of knowing him intimately have lost a valued friend.

A photograph of the late G. O. Day was published in number 8 of the Society's Proceedings.

W. DOWNES.

List of articles by the late G. O. Day published in the Proceedings of The Entomological Society of British Columbia.

		Proceedings
1911*	**Bombycia improvisa,** Edw. and its congeners	No. 1, p. 30-33
1913	Notes on **Xanthia pulchella,** Smith	No. 2, p. 38-40
1913	Notes on **Schizura unicornis,** Smith and Abbot	No. 2, p. 40-41
1913	President's address	No. 3, p. 29-30
1914	President's address	No. 4, p. 39-44
1915	Notes on the early stages of **Calocampa cineritia,** Grote	No. 5, p. 86-87
1915	Notes on the early stages of **Epirrita dilutata,** Denis and Schiff	No. 5, p. 95-96
1915	Nomenclature and classification (Presidential address)	No. 6, p. 99-110
1918	Larva rearing	No. 8, p. 21-27
1919	Life-history of **Perigrapha præses** Grt.	No. 12, p. 17-19
1921	Notes on **Oporinia autumnata** Gn.	No. 14, p. 16
1921	Early stages of **Nepytia phantasmaria** Strecker (Lepidoptera)	No. 18, p. 30-32
1929	On the early stages of **Platyptilia punctidactyla** (Pterophoridae-Lepid.)	No. 25, p. 14-15

* Re dates of publication, see Proceedings No. 38, p. 29-36. 1942.

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Black bugs in my garden patch,
And speckled bugs and red;
A funny little striped bug
With whiskers on his head;
And green bugs, purple bugs,
And bugs of salmon hue,
And all of them seem happy,
For none of them are blue.

(Author?)

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